# OPERATION
AND
# SERVICE
MANUAL

Alco
DIESEL-ELECTRIC

*1500-HP ROAD SWITCHER*
*1500-HP FREIGHT LOCOMOTIVE*
*2000-HP PASSENGER LOCOMOTIVE*

AMERICAN LOCOMOTIVE COMPANY
GENERAL ELECTRIC COMPANY
SCHENECTADY, N. Y.

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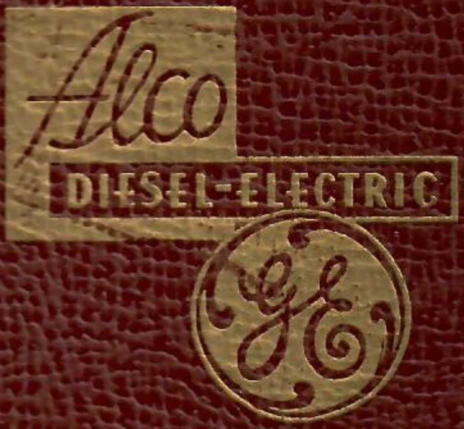
MANUAL


Alco
DIESEL-ELECTRIC
GE

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GENERAL ELECTRIC COMPANY
SCHENECTADY, N. Y.

MULT-O
(PATENTED)

TO OPEN - press bottom levers together with slight clockwise motion.

TO CLOSE - press top levers.

# ION

# CE

Alco
DIESEL-ELECTRIC

ERIE DIESEL
TRAINING CAR #10
ERIE

**1500-HP ROAD SWITCHER**
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ERIE DIESEL
TRAINING CAR #10
ERIE

# OPERATION AND SERVICE MANUAL

## TP-400

This manual covers operation and service of the standard 1500 HP road switcher, 1500 HP road freight and 2000 HP road passenger locomotive.

The purpose of these instructions is to explain how to efficiently operate and service the locomotive at maximum efficiency and minimum expense.

Numbers given in text or illustrations are for reference only and are not to be used for ordering renewal parts.

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**AMERICAN LOCOMOTIVE COMPANY**
**GENERAL ELECTRIC COMPANY**
**Schenectady 5, N. Y.**

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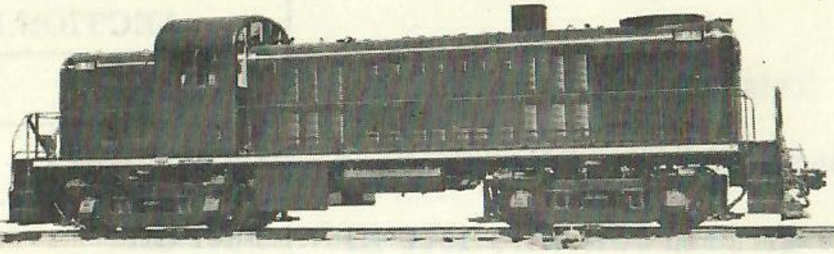
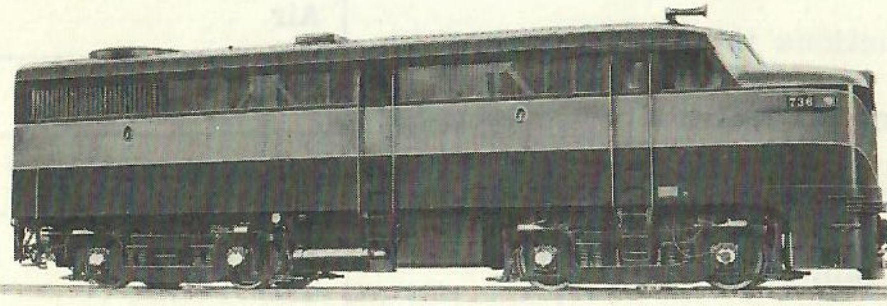


1500 HP ROAD SWITCHER



1500 HP ROAD FREIGHT "A" UNIT

2000 HP ROAD PASSENGER "A" UNIT

# OPERATION

## GENERAL DESCRIPTION

### ROAD LOCOMOTIVES

Road locomotives consist of 1500 HP freight units and 2000 HP passenger units. Units which are equipped with operating cabs are designated as "A" units and can be moved independently while those without cabs are trailing or "B" units and can be moved independently when equipped with hostler controls.

Control wires and air hoses connect the units to provide for multiple unit operation from an operating cab.

Different combinations of 1500 HP freight units may be used to make up a locomotive. A 1500 HP locomotive is a single "A" unit, a 3000 HP is either a combination of two "A" units back to back or an "AB" combination. A 4500 HP locomotive may be either a combination "ABA" or "ABB" while a 6000 HP may be either an "ABBA" or "ABBB".

Different combinations of 2000 HP passenger units may be used to make up a locomotive; a 2000 HP locomotive is a single "A" unit; the 4000 HP either "AA" or "AB" combination or the 6000 HP either "ABA" or "ABB" combination.

### ROAD SWITCHER LOCOMOTIVE

A 1500 HP Road Switcher is a single unit locomotive designed for freight, passenger or switching service. Controls may be applied for multiple unit operation of two, three or four units controlled from one cab.

### DIESEL ENGINES

The Diesel engines are "V" type with a 45° angle between banks. The 1500 HP engine has 12 cylinders while the 2000 HP engine has 16 cylinders. The engine has a bore and stroke of 9" x 10-1/2", is single acting, turbosupercharged, of four stroke cycle having an open combustion chamber with solid fuel injection. An individual fuel injection pump and nozzle is provided for each cylinder.

The engines have a speed range of 350 to 1000 RPM, and are governed by electro-hydraulic governors.

Each cylinder requires two engine revolutions or four strokes of the piston to complete one working cycle. One complete piston working cycle is as follows: first, air is blown into the cylinder on the down or intake stroke; then on the compression stroke, this air is compressed by the rising piston with a large increase in air temperature. Just before the end of the compression stroke, fuel is injected into the cylinder where it is ignited by the heat of the compressed air. The resulting combustion increases the cylinder pressure and on the third or power stroke, this gas pressure forces the piston down. On the fourth or exhaust stroke, the burnt gases are expelled by the piston traveling upwards and by scavenging action of the inlet air made possible by large intake and exhaust valve overlap.

The Diesel engine has an all welded steel frame. Full pressure lubrication of all parts is provided. A closed cooling system is used; the cooling water flows successively through the engine, the radiators and the lubricating oil cooler and is circulated by an engine driven centrifugal pump. Lubricating oil is cooled by the water in the heat exchanger and the water by fan cooled radiators. Thermostatically controlled radiator shutters and fan maintain desired engine temperature automatically.

## TRACTION AND AUXILIARY GENERATORS

The traction generator is direct-connected to the Diesel engine crankshaft while the auxiliary generators are gear driven from the generator shaft on road locomotives and belt driven on the road switcher locomotives.

The traction generator produces direct current for the operation of the traction motors. The amplidyne exciter furnishes excitation for the traction generator; the blower generator furnishes current for the traction motor blower motors on road locomotives and the auxiliary generator furnishes current for battery charging and low voltage circuits for lighting, control, fuel pump and exciter field excitation. There is no blower generator on the road switcher as the traction motor blowers are belt driven.

## TRACTION MOTORS

Four traction motors are used on each unit. Each motor is supported by axle suspension bearings and a spring nest mounted on the truck bolster.

Shrunk onto the motor armature shaft is a pinion which meshes with a drive gear pressed onto the wheel axle. The gear ratio between the pinion and drive gear determines the maximum locomotive speed and is expressed in two figures such as "74/18". The first number indicates the number of teeth on the driven gear and the second number indicates the number of teeth on the pinion.

The traction motors are connected either in series-parallel or parallel depending upon the speed of the locomotive. During acceleration the steps are:

| | |
|---|---|
| No. 1 | Series-Parallel |
| No. 2 | Series-Parallel Shunt (reduced field) |
| No. 3 | Parallel |
| No. 4 | Parallel Shunt (reduced field) |

The steps take place in reverse order when a train is decelerating with power on.

"Transition" is the changing of traction motor connections and is controlled by the movement of the selector handle. Two methods of transition are in use, manual or automatic.

The forward and reverse movement of the locomotive is controlled by the positioning of the reverser in each unit which, when moved from forward to reverse position by controls from the engineer's position, changes the direction of the current through the traction motor field windings.

A blower is provided for each pair of traction motors. The blowers are mounted on the locomotive floor supplying cooling air through ducts to the motors. Motor driven blowers are used on road locomotives while belt driven blowers are used on road switchers.

## AUXILIARY EQUIPMENT

On road and road switching locomotives, the Diesel engine drives the radiator fan through an eddy current clutch and the air compressor through a flexible coupling.

On road locomotives, the blower generator, auxiliary generator and amplidyne exciter are gear driven from the traction generator.

On road switching locomotives, the auxiliary generator and amplidyne exciter are belt driven from a pulley mounted on the traction generator armature shaft.

## DYNAMIC BRAKING (if used)

The dynamic brake is an arrangement of the traction motors, generator and exciter for retarding the locomotive and train. The motors are reconnected as generators. When using this arrangement, the push of the train against the locomotive causes the traction motors to generate electricity and creates a retarding force. This electricity is dissipated in fan blown grids mounted over the Diesel engine in the roof of the cab.

## CONTROLS IN THE OPERATING CAB

Located at the engineer's position are five handles by which the engineer controls the operation of locomotive. These are the Throttle Handle, Reverse Handle and Selector Handle which are mounted in the Control Stand, and the Independent and Automatic Brake Valve Handles.

## THROTTLE HANDLE

The throttle handle controls the Diesel engine speed and has nine positions; "Idle" and eight running notches. When advancing the throttle from one notch to another, it must first be moved toward the OFF position very slightly and then advanced to the next notch. This mechanical interlock prevents quick opening of the throttle thus preventing undesirable locomotive performance. The throttle may be closed as rapidly as desired.

## REVERSE HANDLE

The reverse handle has three positions; Forward, Off and Reverse. This handle controls the direction of locomotive movement and should be positioned only when the locomotive is at a standstill. Moving the handle forward gives forward motion and pulling the handle back gives reverse motion. When the handle is in the center position it is in neutral and the locomotive will not move upon opening the throttle as the power circuits will not close. The reverser will not move from one position to the other until the throttle is opened. As a precautionary measure, the engineer should remove the reverse handle whenever he leaves the locomotive.

## SELECTOR HANDLE

The selector handle, with four power positions, is used for motor transition. It is also used for applying dynamic brakes when a locomotive is so equipped. When moving the selector handle to the left from the OFF position, the handle is in motoring range; when moving it to the right, the handle is in the dynamic braking range. If the locomotive is not equipped with dynamic braking the selector handle is blocked so it cannot be moved into the braking range.

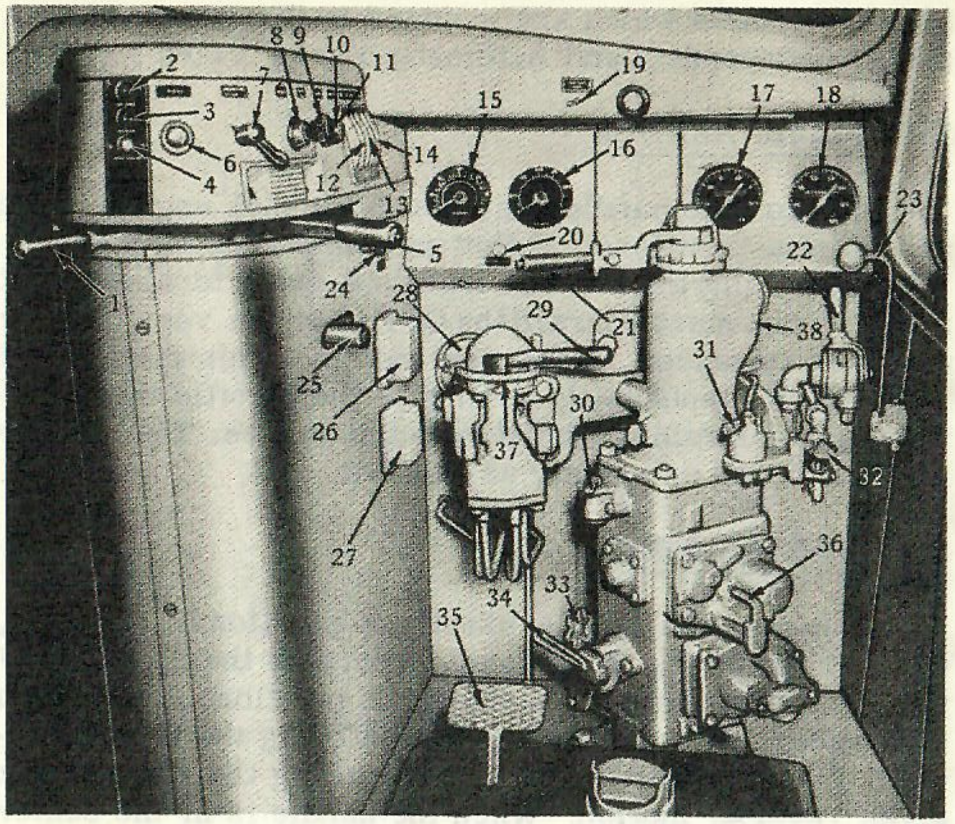


FIG. 1-0
ENGINEER'S POSITION - ROAD LOCOMOTIVE

1. Selector Handle
2. Hot Engine Light
3. Low Lube Oil Pressure Light
4. Boiler Flame Out Light
5. Throttle Handle
6. Call Button
7. Head Light Switch
8. Cab Heater Control
9. Gage Light Control
10. Defroster Control
11. Emergency Stop Button

12. Control Circuit Breaker
13. Generator Field Circuit Breaker
14. Fuel Pump Circuit Breaker
15. Load Indicator
16. Speed Indicator
17. Brake Cylinder and Brake Pipe Air Gage
18. Main and Equalizing Reservoir Air Gage
19. Order Light Switch
20. Wheel Slip Light
21. Automatic Brake Valve Handle
22. Sander Valve
23. Window Handle
24. Windshield Wiper Valve
25. Reverse Handle
26. Alarm Buzzer - low oil pressure, hot engine, ground relay, boiler flame out, traction motor blower off
27. Wheel Slip Buzzer
28. Rotair Valve
29. Independent Brake Valve Handle
30. Selector Cock
31. Bell Valve
32. Horn Valve
33. Feed Valve
34. Double Heading Cock
35. Deadman Pedal
36. Deadman Cut-Out Cock
37. Locomotive Brake Release Bail
38. Deadman Warning Whistle (not shown)

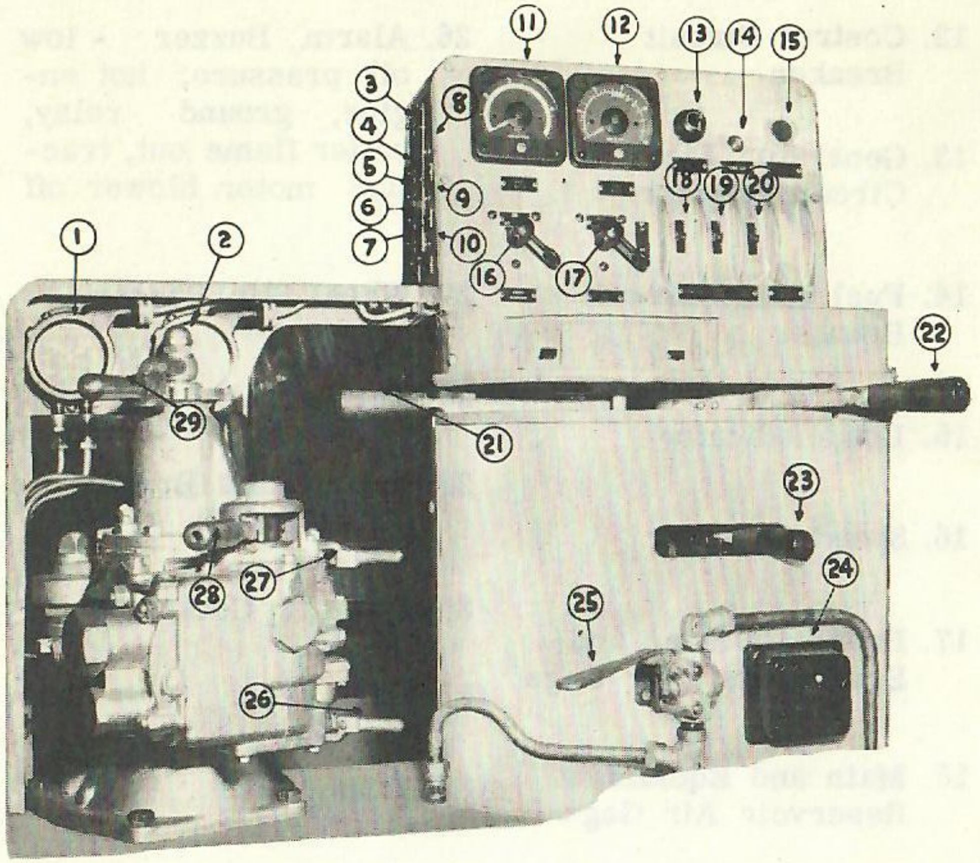


FIG. 2-0
ENGINEER'S POSITION - ROAD SWITCHER

1. Air Brake Gage

   Red - Brake Cylinder
   White - Brake Pipe

2. Air Brake Gage

   Red - Main Reservoir
   White - Equalizing Reservoir

3. Engine Room Light Switch
4. Rear Hood Light Switch
5. Classification Light Switch
6. Number Light Switch
7. Dome Light Switch

8. **Ground Relay Indicating Light**
9. **Hot Engine Indicating Light**
10. **Low Lube Oil Pressure Indicating Light**
11. **Speed Meter**
12. **Load Meter**
13. **Gage Light**
14. **Wheel Slip Indicating Light**
15. **Emergency Engine Shut Down Button**
16. **Front Headlight Switch**
17. **Back Headlight Switch**
18. **Control Switch**
19. **Generator Field Switch**
20. **Fuel Pump Switch**
21. **Selector Handle**
22. **Throttle Handle**
23. **Reverse Handle**
24. **Wheel Slip Buzzer**
25. **Horn Valve**
26. **Bell Valve**
27. **Sander Valve**
28. **Independent Brake Valve Handle**
29. **Automatic Brake Valve Handle**

Free travel of the selector handle past each power position is prevented by two latches built into the handle. A definite sequence of motion is required in moving the handle from one position to another in either direction. The selector handle can be moved when the locomotive is under power; the latches merely impede the motion of the handle.

To pass from one position to another, raise the handle, move it in the desired direction until the lower latch hits the far side of the notch. This is a very slight movement. Then depress the handle and move toward the next position. When the next position is reached, the upper latch will drop into the notch, stop the movement and lock the handle.

## MECHANICAL INTERLOCKS BETWEEN THROTTLE, REVERSE, AND SELECTOR HANDLES

1. Throttle can only be moved if selector handle is in 1, 2, 3 or 4 position.

2. Reverse handle can only be moved if selector handle is in either OFF or #1 position and the throttle is in IDLE position.

3. Selector handle can be moved from OFF to the #1 position regardless of reverse handle position. However, to move the selector handle to the #2 or #3 or #4 position, the reverse handle must be either in forward or reverse position.

On units equipped with dynamic braking, it is necessary that the reverse handle be in the forward position and the throttle in idle to be able to move the selector handle into the braking range.

## AIR BRAKE EQUIPMENT

The 24 RL brake equipment is used on all road locomotives while 6-DS is used on road switchers. Details of this equipment vary on different railroads to meet specific operating requirements.

## 24 RL EQUIPMENT

The cab equipment consists primarily of the automatic brake valve, independent brake valve and rotair valve.

The Automatic Brake Valve Handle has six positions namely, release, running, first service, lap, service and emergency.

In Release Position (extreme left position of brake valve handle) controlled full release is obtained in which the large capacity feed valve provides a high rate of air flow to the brake pipe at feed valve pressure without the liability of overcharge.

In Running Position the air flow to the brake pipe is the same as older feed valve capacities. This position is used to release the brakes when the brakes are charged and ready for use and when the brakes are not being operated.

In First Service Position it provides for an initial normal service rate of brake pipe reduction to initiate quick service on the train brakes, after which a slower rate is imposed, allowing the brake pipe pressure to readjust itself throughout the train thus avoiding a heavy reduction at the front end.

In Service Position the locomotive brakes and train brakes apply uniformly on both a time and pressure basis by delaying the beginning of effective brake cylinder pressure development on the locomotive to coincide with that on the train.

In Emergency Position applications are adjustable to provide slack control according to the services (Rotair Valve Position). This feature provides a rapid development of locomotive brake cylinder pressure for passenger and short freight trains: or a controlled build-up for long freight trains.

The First Service Cock on the back side of the automatic brake valve is used for cutting-in or out the first service operation of the brake valve. When the handle is towards the engineer, it is cut-in.

The Selector Cock on the rotary valve seat portion has two positions; "MR" main reservoir (handle away from engineer) and "FV" feed valve (handle towards engineer). With the handle on "MR" and the automatic brake valve handle in release position, main reservoir air flows to the brake pipe unaffected by the regulating portion of the feed valve and overcharging is possible. When the handle is moved to "FV" position and the automatic brake valve in release or running position, the brake pipe is connected to the control pipe and feed valve pressure will be maintained in the brake pipe.

The Brake Pipe Cut-Out Cock on the lower portion of the automatic brake valve is used for cutting the brake valve in or out. When the handle is pointing away from the engineer, the brake valve is cut in and in the vertical position it is cut out.

The Safety Control Cut-Out Cock on the service application portion is used to cut in or out all safety devices (deadman control, locomotive overspeed and train control if used). With the handle down, all safety devices are cut in.

The Rotair Valve located below the engineer's instrument panel is a manually operated selector valve having four positions; freight, freight lap, passenger and passenger lap. The handle should be placed in "FRGT" position on trains of 51 cars or more where controlled emergency is desired (40-60 seconds delayed emergency action of the locomotive brakes) and "FRGT LAP" on trailing "A" units. In lap position, the independent brake valve is cut out.

The handle should be placed in "PASS" position on trains of 50 cars or less where the controlled emergency feature is inoperative and "PASS LAP" on trailing "A" units.

The Control Valve, located in the nose of "A" units and in the forward end of "B" units, when actuated by the brake valve, operates to charge, apply, and release the brakes. The control valve in "B" units includes the controlled emergency cock which should be positioned at "F" or "P" to correspond with the position of the rotair valve in the leading "A" unit. Common to the control valve in both "A" and "B" units are the charging change-over cock, dead engine cock and graduated release cap. The Charging Change-over Cock should be positioned at "F" or "P" to correspond with the position of the rotair valve in the leading "A" unit. When in "F", charging of the auxiliary reservoir is at a slow rate while in "P", the rate is much faster. The Dead Engine Cock should be in "Live" position for normal operation and "Dead" when the locomotive is hauled dead in a train. The Graduated Release Cap has two positions, graduated "Gra" and direct "Dir". This applies to automatic release of the locomotive brakes which will usually be graduated in passenger and light freight service and direct in heavy freight.

The Independent Brake Valve Handle has two positions, release and application zone. The brake valve is of the self lapping type. Leakage is automatically controlled which insures that the brake will not release due to leakage. When the brake valve handle is set in any position of the application zone, the valve will automatically lap when the applied pressure reaches the value corresponding to the position of the handle. The locomotive brakes may be released after an automatic application by depressing the independent brake valve handle in any position. Brakes will reapply to the setting of the handle, when the handle is released.

The Deadman Pedal is located on the floor in front of the engineer's seat. The pedal must be depressed at all times except when the locomotive is stopped and 30 pounds or more brake cylinder pressure exists. If the pedal is released during operation, the safety control whistle will sound for two to four seconds during which time the pedal can be depressed preventing brake action. Otherwise a full service application of brakes will be made.

A Dynamic Brake Interlock is furnished with dynamic brake equipment and is used to release or prevent an automatic brake application on the locomotive if the dynamic brake is on. Independent application and release of the locomotive brake is available at all times irrespective of dynamic brake operation.

In emergency or any penalty application the dynamic brake is nullified allowing the automatic to operate.

## 6 DS EQUIPMENT

This equipment consists primarily of the automatic brake valve, independent brake valve, bell ringer valve, sander valve, brake pipe cut-out cock, feed valve and distributing valve.

The Automatic Brake Valve Handle has five positions namely: running, holding, lap, service and emergency.

Running Position is used to charge the train brake system, when the brakes are charged and ready for use, when the brakes are not being operated and to release the locomotive and train brakes. In this position the feed valve will charge the brake pipe as rapidly as possible and at feed valve pressure.

Holding Position is used to hold the locomotive brake applied while the train brakes are being released and their auxiliary reservoirs recharged to feed valve pressure.

Lap Position is used while holding the brakes applied after a service application until it is desired either to make a further brake pipe reduction or release them.

Service Position gives a gradual reduction of brake pipe pressure to cause a service application. The gradual reduction is to prevent quick action.

Emergency Position is used for prompt and heavy application of brakes. A large and direct communication between the brake pipe and atmosphere is made causing a sudden and heavy discharge of brake pipe air.

The Brake Pipe Cut-Out Cock located on the back side of the brake valve body is used to open or close the passage between the brake valve and brake pipe. When the handle is vertical, the brake valve is cut out or closed; when the handle is parallel with the floor, it is cut in or open.

The M-3-A Feed Valve attached to the brake valve body regulates pressure in the brake pipe with the automatic brake valve handle in running or holding position. The valve is provided with adjustable stops for double pressure control.

The Independent Brake Valve Handle has two positions, running and application zone. It is of the self lapping type. No fanning of the brake valve handle is necessary as the valve automatically builds up the application pressure to the amount corresponding to the handle position and then laps. The release of the locomotive brakes may be made after an automatic brake application by depressing the independent brake valve handle in running position.

The Distributing Valve located on the left running board to the rear of the cab is the automatic valve mechanism which controls the operation of the brakes on the locomotive in accordance with the movements of both brake valve handles.

The Dead Engine Cock mounted on the distributing valve next to the locomotive hood is to be open (parallel with floor) when a locomotive is to be hauled dead in a train and closed (vertical position) under all other conditions.

The Multiple Operation Cock mounted in the cross-over pipe above the distributing valve is used for multiple unit operation only. For single unit operation, a dead engine or the leading unit of a multiple unit locomotive, the handle should be parallel with the pipe. If the unit is trailing in a multiple unit locomotive, the handle should be perpendicular to the pipe.

## MISCELLANEOUS EQUIPMENT

### LOCOMOTIVE BELL VALVE

The locomotive signal bell is located under the chassis behind the pilot on road locomotives and behind the right front corner steps on road switchers. It is operated from main reservoir air through the lower control valve on the right side of the brake valve pedestal. The shut-off valve is built in the needle valve adjustment at the bell.

### HORN VALVE

The locomotive horn is operated from main reservoir air through the control valve located at the engineer's position. On road locomotives, the horn shut-off cock is located in the right corner of the nose just above the floor while on road switchers this cut-out cock is located in the bottom of the control stand and reached by removing the lower cover plate.

### SANDER VALVE

The sander valve, on road switchers, is the upper control valve on the right side of the brake valve pedestal. The handle has three positions; reverse, neutral and forward. The extreme right position admits main reservoir air to the sander automatic valve giving forward sanding while the extreme left position gives reverse sanding. In neutral position the exhaust warning port is closed and no sand flows. A sander shut-off cock is provided for each truck, located under the chassis near the sander automatic valve.

On road locomotives, a single acting independent sanding valve is employed. The valve is operated by pulling the lever all the way back admitting main reservoir air to the sander automatic valves. A shut-off cock is provided for each truck, located under the chassis on the left side near the sander automatic valve.

### WINDSHIELD WIPER VALVES

On road locomotives, two windshield wipers operated from main reservoir pressure are provided, the speed of each being controlled independently by a regulating screw which also turns the wiper on and off. One is located on the engineer's control stand and one on the panel at the fireman's position. The shut-off cock is located in the nose in the upper right corner.

On road switchers, four windshield wipers operated from main reservoir pressure are provided, the speed of each being controlled independently by a needle valve which also turns the wiper on and off. The operating valves are located at each wiper at front and back windows on the right and left sides of the cab. The shut-off globe valve is located in the bottom of the control stand and reached by removing the lower cover plate.

### CAB HEATERS

On road locomotives a heater is located on each side of the cab while on road switchers it is located on the right side in front of the engineer's position. Hot water from the engine cooling system passes through the heaters and motor driven fans provide air circulation. Rheostat switches, in easy reach of the operator, are used to vary the output. Water inlet and outlet valves are provided for each heater. They are located near the heater in the nose on road locomotives and under the engine hood to the rear on road switchers. A manual vent valve located on the top of each heater, is provided to eliminate air pockets.

## DEFROSTERS

Road locomotives are equipped with two motor driven defroster fans which blow cab heater air on the insides of both windshields. Each motor is operated individually by a rheostat switch which will vary the output of the defroster as well as turn it on and off. One switch is located on the engineer's control stand and one on the fireman's panel.

## CLASSIFICATION LIGHTS

On each side of the nose on a road locomotive are two permanently fixed clear glass bull's-eye lenses, one facing forward and one to the side. Accessible from the nose is a classification light lamp and cage containing three colored lenses; red, green and yellow. The cage is equipped with a locking pin which when pulled out disengages the locking device so that the cage may be rotated to obtain the desired colors. When the colored lenses are out of position, the white light will show thus making several combinations available.

## GAUGES AND METERS

## ENGINEER'S CONTROL PANEL

### Load Meter

Each "A" unit and road switcher locomotive is equipped with a load meter which is used by the engineer as a guide for the operation of the throttle during motoring, and the selector handle in the braking range if dynamic braking is furnished. By careful observance of this meter, the engineer may get the maximum performance from the locomotive and guard against abusive overloading of the traction motors. Two types of meters are in use. One is designed with the outer scale divided into three colored zones, the other is divided into two colored zones with the last zone marked off in minutes.

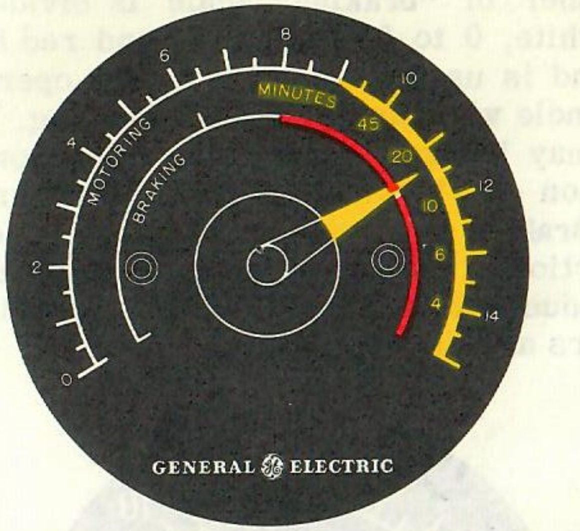


FIG. 3-0
LOAD METER

On one type, Fig. 3-0, the "motoring" scale is white from 0 to 900 amperes which is the continuous rating of the traction motors. In this zone operation is unlimited. From 900 to 1500 amperes the scale is yellow indicating limited operation. The yellow figures beneath this portion of the scale indicates the time in MINUTES these loads may be maintained. The operating time in this zone is not accumulative. When the locomotive has been operated at any of the overloads for the full time shown, or a combination of the overloads (for example, part time at the 10 minute rating and part time at the 20 minute rating) the load must be reduced into the white zone, 900 amperes or less, for one hour before repeating an overload.

By this guide the engineer can determine quickly when an emergency overload condition arises. It will indicate whether he can reach the top of the grade or into the next siding within the overload time limit, or if he should stop immediately and reduce tonnage, double the hill, or obtain the assistance of a helper locomotive.

The inner or "braking" scale is divided into two zones -- white, 0 to 800 amperes and red 800 to 1500 amperes and is used as a guide for the operation of the selector handle when using dynamic braking. Continuous operation may be had for any pointer position within the white portion of the scale except as described under "Dynamic Braking Limit". Any position of the pointer in the red portion of the scale indicates an overload which MUST be reduced immediately to prevent possible damage to the motors and the resistor assembly.

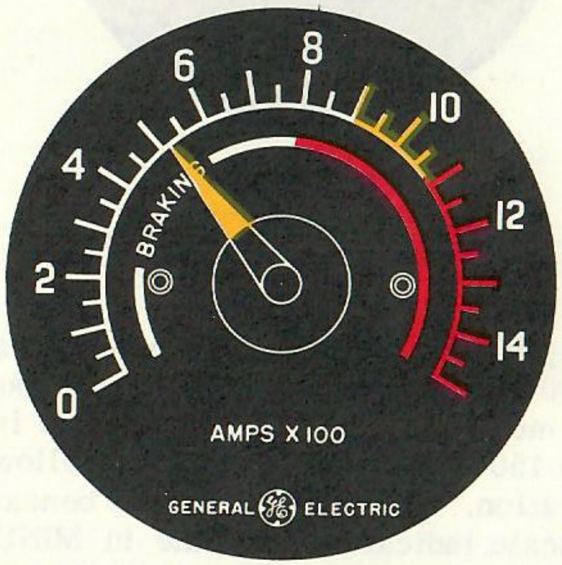


FIG. 4-0
LOAD METER

On the other type, Fig. 4-0, the red zone at the high current end of the scale represents a heavy overload. Operation in this zone is normally used for starting and accelerating the train. A train of the proper tonnage should not require more than approximately 4 minutes operation in this zone.

Yellow zone operation is permissible for a consecutively or accumulated time not to exceed 90 minutes. Continuous operation is permisslble in the white zone.

### Speed-Transition Meter

Units having manual transition are equipped with speed-transition meters having two scales. The outer scale is calibrated in miles per hour, while the inner scale is marked 1, 2, 3 and 4 which represents the four transition positions of the selector handle. As the speed of the locomotive increases or decreases, the selector handle should be moved to the corresponding position indicated by the pointer.

On locomotives equipped with automatic transition, the inner scale is omitted leaving only the miles per hour scale.

### Air Gauges

Two standard air gauges are furnished, one indicating brake cylinder and brake pipe air pressure while the other main reservoir and equalizing air pressure.

## CONTROL COMPARTMENT PANEL

### Battery Voltmeter

This instrument should indicate a battery voltage of 64 when the engine is shut down and the battery switch closed. A lower reading than this would indicate that the battery is not fully charged or has faulty cells. With the engine running it indicates auxiliary generator voltage and the needle should be in the green area at approximately 74 volts.

### Auxiliary Generator Ammeter

Ths instrument indicates the ampere output of the auxiliary generator and should normally show a slight charge. It will vary depending upon the auxiliaries being operated, such as the fuel pump motor, crankcase exhauster, motor-generator set, eddy current clutch, etc. and will show a high charging rate immediately after cranking the engine.

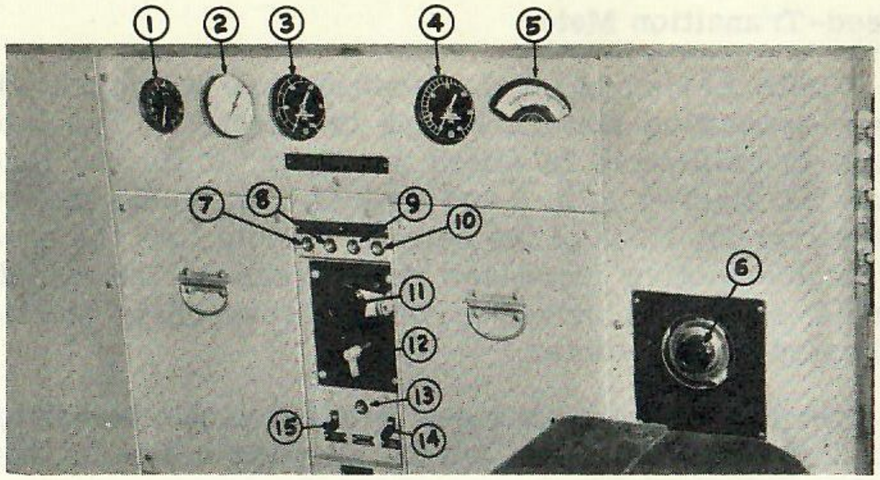


FIG. 5-0

ENGINE CONTROL PANEL - ROAD LOCOMOTIVES

1. Engine Speed Indicator
2. Lube Oil Pressure Gauge
3. Fuel Oil Pressure Gauge
4. Turbosupercharger Air Pressure Gauge
5. Engine Water Temperature Gauge
6. Radiator Fan Control Switch
7. Ground Relay or Blower Stop Indicating Light
8. Boiler Flame Out Indicating Light (If Used)
9. Low Lubricating Oil Pressure Indicating Light
10. Hot Engine Indicating Light
11. Engine Control Switch
12. Engine Start Switch
13. Crankcase Exhauster Running Light
14. Fuel Pump Switch
15. Panel Light Switch

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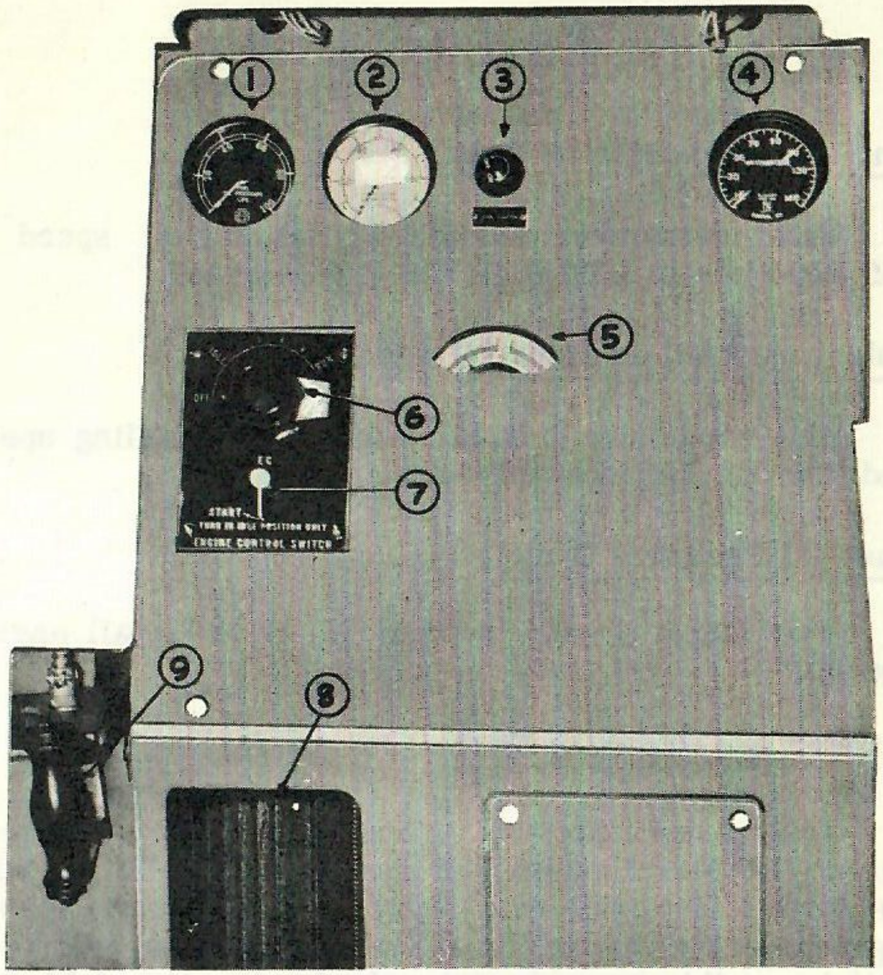

FIG. 6-0

ENGINE CONTROL PANEL - ROAD SWITCHER

1. Fuel Oil Pressure Gauge
2. Lubricating Oil Pressure Gauge
3. Cab Heater Control
4. Control Air Gauge
5. Engine Water Temperature Gauge
6. Engine Control Switch
7. Engine Start Switch
8. Cab Heater Outlet
9. Battery Switch

## ENGINE CONTROL PANEL

### Engine Tachometer (If Used)

This instrument denotes Diesel engine speed -- 350 RPM idle to 1000 RPM full engine speed.

### Lubricating Oil Pressure Gauge

This gauge should indicate 20-25 psi at idling speed and from 45-55 psi at full engine speed.

### Fuel Oil Pressure Gauge

This gauge should indicate 35-45 psi at all engine speeds.

### Booster Air Pressure Gauge

This gauge indicates turbosupercharger air pressure to the Diesel engine and should show 15-18 psi with the throttle in eighth notch fully loaded and correspondingly lower values in lower throttle notches. On road switchers, this gauge is under the hood on the right side of the radiator compartment bulkhead.

### Engine Water Temperature Gauge (If Used)

This gauge indicates temperature of the cooling water out of the left bank header of engine. The normal operating temperature is 140° to 160° F.

### Control Air Pressure Gauge

This gauge on road locomotives is mounted in the nose on the fireman's bulkhead while on the road switcher it is on the engine control panel. It should show 70 psi.

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## MISCELLANEOUS

### Radiator Fan Control Air Pressure Gauge

This gauge on road locomotives is mounted to the right of the Engine Control Panel while on road switchers it is to the right of the fan control under the hood on the left side of the radiator compartment bulkhead. It should indicate 15-17 psi for operation of the electro-pneumatic fan control switches.

### Main Reservoir Pressure Gauge

This gauge is located on the left side wall on road locomotives near the air compressor governor and is used as a guide in setting the compressor governor.

### Engine Water Temperature Gauge

A second engine water temperature gauge is located in the right engine outlet water header near the radiator compartment. The normal operating temperature is 140° - 160° F.

## ALARMS AND INDICATING LIGHTS

### Hot Engine Light

When the temperature of the engine cooling water reaches 185° F the high water temperature switch will close causing the "hot engine" red indicating lights to light, sound the buzzer (road locomotives only) and the alarm bell in all units as well as return the affected engine to idle (road locomotives only).

### Low Lubricating Oil Pressure Light

When the engine lubricating oil pressure drops to 20 psi, but not below 7 psi, with the throttle in the 5th, 6th, 7th, or 8th notch and with the engine control switch in "6" or "run", the oil pressure switch OPS 1 will open lighting the low lubricating oil pressure green light, sound the buzzer (road locomotives only) and the alarm bell in all units as well as return the affected engine to idle. If the pressure drops to 7 psi or below, OPS 2 will open causing the alarm to sound and the affected engine to shut down regardless of throttle or engine control switch positions.

### Boiler Flame Out Light

If a unit is equipped with a steam generator and it stops, the boiler alarm relay will close causing the "boiler flame out" white light to light, buzzer (road locomotives only) and the alarm bells to sound in all units.

### Ground Relay and Blower Light

On road locomotives if a ground occurs in the high voltage circuit of any unit or connected units, the white "ground relay and blower" light will light in the unit affected. The buzzer and alarm bell will sound in all units and the affected engine will return to idle. If a traction motor blower failure occurs, the white light will light in the affected unit. The buzzer and the alarm bells will sound in all units.

### Ground Relay Light

On single or multiple connected road switching locomotives if a ground occurs in the high voltage circuit, the white "ground relay" light will light and the engine will return to idle on the locomotive affected while the alarm bells will ring in all locomotives.

### Wheel Slip Light

Two wheel slip relays are provided per unit, one across the No. 1 and 4 traction motors and one across No. 2 and 3 motors. If one pair of wheels slip, the white "wheel slip" light will come on, the buzzer will sound and the generator output will be reduced. This is due to a difference in current through the two motor fields. If there is repeated wheel slippage, the throttle should be partially closed and then gradually reopened. If it becomes necessary to use sand, be sure the throttle is reduced, to stop flashing of the wheel slip light, before applying sand. During transition from 2 to 3 or 3 to 2, the wheel slip light will come on for an instant; however this is not an indication of wheel slippage.

### Crankcase Exhauster Light

A yellow crankcase exhauster light lights when the fuel pump switch on the Engine Control Panel is turned ON and indicates the crankcase exhauster motor is running. The light should be ON continuously whenever the Diesel engine is running. If the light goes out during operation, it indicates either the exhauster motor has stopped or the lamp has burned out.

### Dynamic Braking Warning Light (If Used)

A white dynamic braking warning light and relay are provided on locomotives equipped with dynamic brake. When the relay closes, the warning light at the engineer's position will light indicating that the load on the dynamic brake is excessive and should be reduced to the continuous rating of the electrical equipment. The engineer should observe the load indicator as well as the warning light. The operating range for dynamic braking is from 0 to 800 amperes. However, since two braking resistors per unit are employed, the warning light is placed across one resistor and trainlined while the loadmeter is across the second. In some cases, the warning light may come on before the 800 amperes is reached on the loadmeter due to variations in adjustments. Observe whichever comes first, the light or 800 amperes, and reduce the load accordingly.

## OPERATION

## PREPARING FOR OPERATION

### ROAD LOCOMOTIVE

1. Close battery switch located directly beneath Engine Control Panel.

2. If lights are needed close circuit breakers for cab lights and engine room. Close light switches near engine room side doors.

3. Inspect engine room; make sure that no rags, tools, lanterns, etc., are near any shaft, moving parts or electrical apparatus.

4. Check engine lubricating oil level on each unit. Bayonet gauge should show oil between the high and low marks

5. Check the fuel oil level on each unit.

6. Check the cooling water level on each unit. A sight level water glass is attached to the expansion tank and water should show in the glass at all times.

7. Check the water supply in the steam generator water tanks if used. Tanks should be checked for quantity by opening the air supply valve to the water level indicator and may be filled from either side of the locomotive.

8. The power plant governor operates under hydraulic pressure and a separate oil tank is furnished. Check oil level with the fuel booster pump shut down. The tank is located on the right side of the locomotive at the air compressor end of the Diesel engine, directly below the power plant governor.

9. Check sand supply.

10. All emergency fuel shut-off valves at fuel tanks should be open and all engine water and lubricating oil drain valves closed on all units.

11. Handles on duplex fuel-oil filters should be either in the horizontal or vertical position, preferably horizontal.

12. Pointer on traction motor cut-out switch should indicate "All Motors In" on all units.

13. Ground relay cut-out switch should be closed and ground relay red indicator should not show on any unit. To reset have throttle closed and push reset button.

14. The radiator fan control switch should be in Automatic position and the wing nut on each shutter operating handle loose.

15. Air compressor governor cut-out cock should be open on all units.

16. The throttle should be in Idle, reverse and selector handles in OFF position on all units.

17. The Diesel engine turning gear must be disengaged and locked. This is located at air compressor end of engine and mounted directly above the engine crankshaft extension.

18. The Diesel engine Overspeed Reset Button should be in on all units.

19. Check oil level in air compressors on each unit. Maintain oil level at full mark on bayonet gauge with engine shut down.

20. Check level of oil in gear case of gear-driven aux-

iliaries on each unit by unscrewing the bayonet gauge, wiping it clean and inserting in oil sump with flat side up without engaging the threads. The threads should be engaged when the bayonet gauge is finally put in place. Oil level should be maintained at the FULL mark with the engine shut down.

## ROAD SWITCHER

1. Close the battery switch by pushing in the extension handle located to the right of the control compartment ahead of the control stand.
2. If lights are needed, close circuit breaker for cab lights and auxiliaries and necessary toggle switches.
3. Inspect engine compartment to see that no rags, tools, lanterns, etc., are near shafts, belts, or other moving parts or electrical apparatus. Waste should never be used on the locomotive.
4. Check the level of the Diesel engine lubricating oil system. Bayonet gauge should show oil between the high and low marks.
5. Check the fuel oil level.
6. Check the quantity of water in the cooling water system. The sight glass attached to the water expansion tank should show water at all times.
7. The power plant governor operates under hydraulic oil pressure and a separate oil tank is furnished for governor operation. Check the oil level with fuel booster pump shut down. The tank is located on the left side of the locomotive at the air compressor end of the Diesel engine directly below the power plant governor.
8. Check sand supply.

9. The emergency fuel shut-off valve should be open. If closed, reset by raising the valve stem and slipping the crutch under the raised stem.
10. Make sure that the cooling water drain valve is closed.
11. All lubricating oil drain valves should be closed and the pipe cap on the external drain pipe securely tightened.
12. The handle on the duplex fuel-oil filter should be either in the horizontal or vertical position, preferably horizontal.
13. The traction motor cut-out switch pointer should indicate "All Motors In". The ground relay cut-out switch should be closed and the ground relay indicator should not show red. To reset the ground relay have the throttle closed and push reset button.
14. The radiator shutters should be under automatic control by having hinged latch disengaged from the manual shutter operating arm. The radiator fan control switch should be in automatic position.
15. The air compressor governor cut-out cock must be open.
16. The throttle should be in IDLE, reverse and selector handle in OFF position.
17. Diesel engine turning gear must be disengaged and locked. This is located at the air compressor end of the engine and mounted directly above the engine crankshaft extension.
18. The Diesel engine overspeed reset button must be in.
19. Check the air compressor oil level. Maintain the oil level at the full mark on the bayonet gauge with the engine shut down.

## DIESEL ENGINE STARTING

### STARTING ENGINE ON "A" UNIT

Starting the Diesel engine on an "A" unit involves three control panels and the battery switch:-

One control panel is located in the operating cab on the center of the bulkhead between the operating cab and the engine room and is called the Control Compartment Panel.

A second control panel is mounted on top of the control stand to the left of the engineer's seat and is called Engineer's Control Panel.

The third control panel is located on the side wall of the engine room, right side, opposite the air compressor and is called Engine Control Panel.

The battery switch is located directly beneath the Engine Control Panel and is operated by a handle extending through the side of the box.

All circuits are protected by automatic circuit breakers there being no fuses on the unit except those on the Steam Generator Panel when a locomotive is so equipped.

1. Close battery switch.

2. Place selector handle in OFF position.

3. Place throttle handle in IDLE position.

4. Place reverser handle in OFF position.

5. Close the following circuit breakers located on Control Compartment Panel:-

   Engine Room Lights
   Cab Light and Auxiliaries
   Headlight
   Steam Generator Positive (If Used)
   Steam Generator Negative (If Used)
   Fuel Pump
   Crankcase Exhauster
   Blower Generator
   Control Negative
   Control Positive
   Auxiliary Generator
   Auxiliary Generator Field
   MG Set
   Blower Generator Field

6. Close the control and fuel pump circuit breakers located on the Engineer's Control Panel.

7. Close the panel light and fuel pump switches located on Engine Control Panel. Allow fuel oil pressure to build up to 35-45 psi as indicated on fuel oil pressure gauge mounted on Engine Control Panel.

8. On this same panel turn Engine Control Switch to IDLE position. Low oil pressure green light will light and alarm bell will ring until after engine is started.

9. Wait until the three brush arms on front of the governor stop moving. Ten seconds is usually sufficient time for the governor to reset. Turn engine starting switch to the LEFT as indicated on the Engine Control Panel. HOLD in this position while the engine is cranking until oil pressure shows on the gauge, the green light goes out and the alarm bell stops ringing. Releasing the start switch before the green light goes out will stop the engine and the above procedure will have to be repeated.

While engine is being cranked, observe the fuel pump racks. These racks should come out immediately after the engine start switch is thrown to the START position. If they do not, release the engine start switch and turn engine control switch to OFF position. Return engine control switch to IDLE and repeat cranking process. Do not discharge battery by repeated attempts if the first two or three are not successful.

10. Check lubricating oil pressure gauge on Engine Control Panel for 20 pounds minimum pressure.

11. Open crankcase exhauster circuit breaker on the Control Compartment Panel.

12. Check level of engine lubricating oil system. The level should be kept at the high mark on the bayonet gauge with the engine idling, crankcase exhauster shut off and the locomotive on a level track.

13. Close crankcase exhauster circuit breaker on Control Compartment Panel.

14. Make sure crankcase exhauster light on Engine Control Panel is ON.

15. The ground relay and traction motor blower indicating lights on the Engine Control Panel should be OFF and each traction motor blower running.

16. Move the engine control switch on the Engine Control Panel to RUN.

## STARTING ENGINE ON "B" UNIT WITHOUT HOSTLER'S STATION

Starting the Diesel engine on a "B" unit without a hostler's station involves two control panels, the battery switch and an "A" unit.

The Control Compartment Panel is located in the engine room directly ahead of the main generator facing the end door.

The Engine Control Panel is located on the right side wall of the engine room across the aisle from the governor with the battery switch directly below the panel.

## ON "A" UNIT

1. Close battery switch.

2. Close positive and negative control circuit breakers on Control Compartment Panel.

3. Close control and fuel pump circuit breakers on Engineer's Control Panel.

## ON "B" UNIT

1. Close battery switch.

2. Close the following circuit breakers on Control Compartment Panel.

   Engine Room Lights
   Blower Generator Field
   Auxiliary Generator Field
   Auxiliary Generator
   Crankcase Exhauster
   Control Negative
   Control Positive
   Blower Generator
   Fuel Pump
   MG Set

3. Close the panel light and fuel pump switches. Allow pressure to build up to 35-45 psi as indicated on fuel oil pressure gauge mounted on Engine Control Panel.

4. On this same panel turn engine control switch to IDLE position. Low oil pressure green light will light and alarm bell will ring until the engine is started.

5. Wait until the three brush arms on front of the governor stop moving. Ten seconds is usually sufficient time for the governor to reset. Turn the engine starting switch to the LEFT as indicated on the Engine Control Panel. HOLD in this position while the engine is cranking until the oil pressure shows on the gauge, the green light goes out and the alarm bell stops ringing. Releasing the start switch before the green light goes out will stop the engine and the above procedure will have to be repeated. While engine is being cranked, observe the fuel pump racks. These racks should come out immediately after the engine start switch is thrown to the START position. If they do not, release the engine start switch and turn engine control switch to OFF position. Return engine control switch to IDLE and repeat cranking process.

   Do not discharge battery by repeated attempts if the first two or three are not successful.

6. Check lubricating oil pressure gauge on Engine Control Panel for 20 pounds minimum pressure.

7. Open crankcase exhauster circuit breaker on Control Compartment Panel.

8. Check level of engine lubricating oil system. The level should be kept at the HIGH mark on the bayonet gauge with the engine idling, crankcase exhauster shut off and the locomotive on a level track.

9. Close crankcase exhauster circuit breaker on Control Compartment Panel.

10. Make sure crankcase exhauster light on Engine Control Panel is ON.

11. The ground relay and traction motor blower indicating light on the Engine Control Panel should be OFF.

12. Move the engine control switch on the Engine Control Panel to RUN position pausing three seconds at each intermediate position.

## STARTING ENGINE ON "B" UNIT WITH HOSTLER'S STATION

In order to start the engine on a "B" unit with a hostler's station, there are three sets of switches, circuit breakers and a battery switch involved:

One set of switches is on the Engine Control Panel located on the side wall of the engine room, opposite the power plant governor with the battery switch located directly below the panel.

A second set is on the Control Compartment Panel located in the engine room directly ahead of the main generator facing the end door.

The third set is on the Control Panel at the hostler's station.

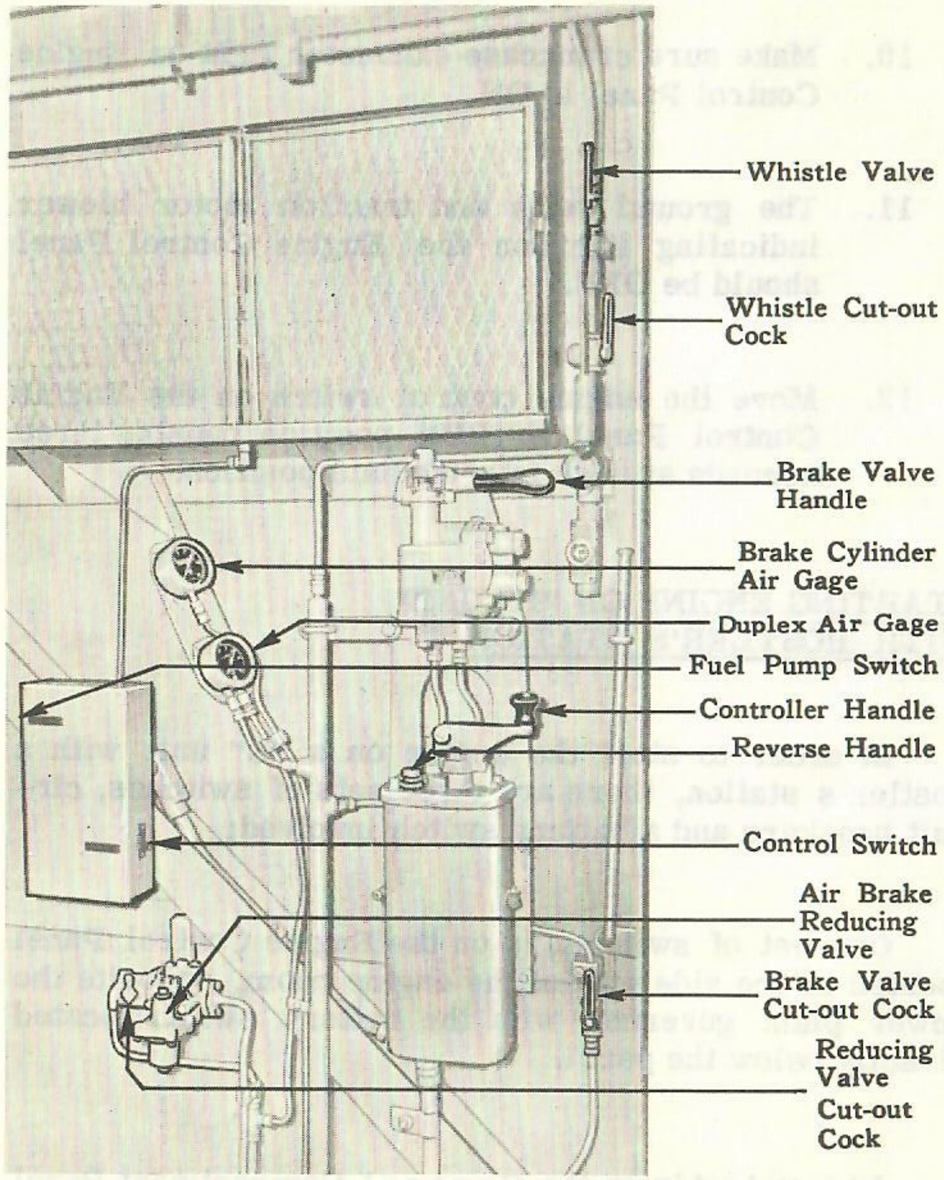
Whistle Valve
Whistle Cut-out Cock
Brake Valve Handle
Brake Cylinder Air Gage
Duplex Air Gage
Fuel Pump Switch
Controller Handle
Reverse Handle
Control Switch
Air Brake Reducing Valve
Brake Valve Cut-out Cock
Reducing Valve Cut-out Cock

FIG. 7-0
HOSTLER'S STATION

1. **Place controller handle at hostler's station in OFF position.**

2. **Place reverse handle in OFF position.**

3. **Close battery switch.**

4. **Close all circuit breakers on the Contactor Compartment Panel. Panel is the same as on "B" unit without hostler's station.**

5. **Close the control and fuel pump switches on the Control Panel at the hostler's station.**

6. **Close panel light and fuel pump switches on the Engine Control Panel. Allow pressure to build up to 35-45 psi on fuel oil pressure gauge mounted on Engine Control Panel.**

7. **Turn engine control switch on Engine Control Panel to IDLE position. Low oil pressure green light will light and alarm bell will ring until after engine is started.**

8. **Wait until the three brusharms on the front of the governor stop moving. Ten seconds is usually sufficient time for the governor to reset.**

9. **Turn start switch on Engine Control Panel to the left to crank engine. Hold in this position while cranking the engine until oil pressure shows on the gauge, alarm stops and green light goes out. Releasing the start switch before the green light goes out will stop the engine and the above procedure will have to be repeated.**

**While engine is being cranked observe the engine fuel pump racks. These racks should come out immediately after the engine start switch is thrown to the START position. If they do not,**

release the engine start switch and turn engine control switch to OFF position. Return engine control switch to IDLE and repeat cranking process.

Do not discharge battery by repeated attempts if the first two or three are not successful.

10. Check lubricating oil pressure gauge on Engine Control Panel for 20 pound minimum pressure.

11. Open crankcase exhauster circuit breaker on Control Compartment Panel.

12. Check level of engine lubricating oil system. The level should be kept at the HIGH mark on the bayonet gauge with the engine idling, crankcase exhauster shut off and the locomotive on a level track.

13. Close crankcase exhauster circuit breaker on Control Compartment Panel.

14. Make sure crankcase exhauster light on Engine Control Panel is ON.

15. The ground relay and traction motor blower indicating light on the Engine Control Panel should be OFF.

16. Move engine control switch on the Engine Control Panel to RUN position pausing three seconds at each intermediate position.

## MOVING "B" UNIT WITH HOSTLER'S STATION

### PRELIMINARIES

1. Check for main reservoir air pressure.
2. Have 70 pounds of control air pressure. Gauge is located at the front end, left side wall.
3. Apply brake valve handle in full application position and then move it to release position.
4. Open brake valve cutout cock.
5. Open reducing valve cutout cock.
6. Place controlled emergency and charging change-over cutout cocks on D-24 control valve in Passenger position.
7. Make brake application.
8. Release handbrake.

## MANEUVERING "B" UNIT WITH HOSTLER'S STATION

1. Move reverse handle to forward or reverse position depending upon direction desired. Move handle toward side panel for forward movement; toward engine for reverse movement.
2. Release air brakes and notch out controller handle. The unit moves in series-parallel motoring only.
3. Move controller handle to OFF position and bring unit to full stop before reversing its movement.

## SHUTTING DOWN ENGINE ON "B" UNIT WITH HOSTLER'S STATION

1. Turn engine control switch on Engine Control Panel to OFF position.
2. Open fuel pump switch on the Engine Control Panel.
3. Open fuel pump and control switches on the Control Panel at the hostler's station.
4. Open battery switch.

## WHEN LEAVING "B" UNIT AT ANY TIME

1. Move brake valve handle to release position.
2. Close brake valve cutout cock.
3. Close reducing valve cutout cock.
4. Move brake valve handle to full application position and remove.
5. Apply handbrake.

## STARTING ENGINE ON ROAD SWITCHER LOCOMOTIVE

In order to start the Diesel engine there are three sets of switches, circuit breakers and a battery switch involved.

One set is located on the Engineer's Control Panel to the left of the engineer's seat.

A second set is located on the Engine Control Panel directly in front of the engineer's seat.

A third set is located on the Control Compartment Panel between the operating cab and the Engine Compartment.

The battery switch handle is located to the left of the Engine Control Panel ahead of the control stand near the cab floor.

All circuits are protected by automatic circuit breakers there being no fuses on the locomotive.

1. Close battery switch.
2. Place selector handle in OFF position.
3. Place throttle in IDLE.
4. Place reverse handle in OFF position.
5. Close the following circuit breakers on the Control Compartment Panel.

   Headlight
   Cab Lights and Auxiliaries
   Fuel Pump
   MG Set
   Engine Room Lights
   Steam Generator Negative (if Used)
   Crankcase Exhauster
   Control Negative
   Control Positive
   Auxiliary Generator
   Auxiliary Generator Field
   Steam Generator Positive (If Used)

6. Close the control and fuel pump switches on the Engine Control Panel. Allow pressure to build up to 35-45 psi on fuel oil pressure gauge mounted on Engine Control Panel.
7. Turn engine control switch on the Engine Control Panel to IDLE. Low oil pressure green light will light and alarm bell will ring until engine is started.
8. Wait until the three brusharms on the front of the governor stop moving. Ten seconds is usually sufficient time for the governor to reset.

9. Turn start switch on Engine Control Panel to the left to crank engine. Hold in this position while cranking the engine until oil pressure shows on gauge, alarm stops and green light goes out. Releasing the start switch before the green light goes out will stop the engine and the above procedure will have to be repeated.

   Do not discharge battery by repeated attempts if the first two or three are not successful.

10. Check lubricating oil pressure gauge on Engine Control Panel for 20 pounds minimum pressure.

11. Open crankcase exhauster circuit breaker located on Control Compartment Panel.

12. Check level of engine lubricating oil system. The level should be kept at the HIGH mark on the bayonet gauge with the engine idling, crankcase exhauster shut off and the locomotive on a level track.

13. Close crankcase exhauster circuit breaker located on Control Compartment Panel.

14. Make sure crankcase exhauster light on Engine Control Panel is ON.

15. Move engine control switch on the Engine Control Panel to RUN position pausing three seconds at each intermediate position.

## COUPLING LOCOMOTIVE UNITS

### ROAD LOCOMOTIVES

When making up a locomotive using "A" and "B" units it is necessary that the various controls be properly positioned.

1. All switches, circuit breakers and cutout cocks in the leading "A" unit should be in the same position as when operating a single "A" unit.

2. Place the rotair valve on the leading "A" unit in Freight position if the train is to be 51 cars or more and Passenger position if the train is to be 50 cars or less.

3. On the trailing "A" unit, all switches and circuit breakers must be ON as in the leading "A" unit, with the exception of the control, generator field and fuel pump switches on the Engineer's Control Panel. These must be in the OFF position. The throttle must be in IDLE, selector handle in OFF and the reverse handle placed in OFF position and removed. The rotair valve handle must be in Passenger Lap if the train is to be 50 cars or less and Freight Lap if the train is to be 51 cars or more. Place automatic brake valve handle in Running position and independent brake valve handle in Release position and remove both handles.

4. On trailing "B" units with hostler stations, all switches and circuit breakers should be in the same position as when moving a single "B" unit with the exception of the fuel pump and control switches at the hostler's position, both of which must remain in OFF position. The brake valve cutout cock and the reducing valve cutout cock at the hostler's position should be closed. The brake valve handle, controller handle and reverse handle should be removed.

5. On the D-24 control valve set the charging change-over cock in the same position on all units as the rotair valve on the leading "A" unit.

6. On the D-24 control valve on "B" units, set the controlled emergency cutout cock in the same position as the charging change-over cock. "F" for freight and "P" for passenger.

7. See that air hoses and multiple-unit jumpers are properly connected and the air line cutout cocks are open.

## ROAD SWITCHER LOCOMOTIVES

When connecting multiple-unit equipped locomotives, the various controls should be properly positioned.

1. All switches and cutout cocks in the leading locomotive should be in the same position as if operating a single locomotive.

2. On the trailing locomotives all switches must be ON with the exception of the control, generator field and fuel pump switches located on the Engineer's Control Panel.. These must be in OFF position. The throttle must be in IDLE, selector handle in OFF position, reverse handle placed in OFF and removed, the independent brake valve handle placed in Running position and the automatic brake valve handle in Lap or Holding position. The double-heading cock on the brake valve pedestal must be in cutout position. The multiple-operation cutout cock located on the crossover pipe above the distributing valve must be open (crosswise with the pipe).

3. See that air hoses and multiple-unit jumpers are properly connected between locomotives and the air line cutout cocks are open.

### SEPARATING UNITS

1. Before separating or closing cocks between units, make a full service automatic application from the lead unit.

2. Set the reducing valve at or near the brake pipe pressure carried on the leading "A" unit.

3. Close all end cocks on both ends of unit and part the air hoses.

## OPERATION OF ROAD LOCOMOTIVES

### BEFORE MOVING A TRAIN

1. Install brake valve handles and reverse lever.
2. Check for main reservoir pressure.
3. Have 70 pounds of control air pressure.
4. Apply brake cylinder pressure of 30 pounds minimum, cut in safety control, release hand brake.
5. Test sanders.
6. Make air brake test.
7. Have at least 120° F water temperature (if possible) as shown on Engine Control Panel gauge before notching up.

### PRELIMINARIES IN HANDLING A TRAIN WITH ROAD LOCOMOTIVE

1. Close generator field switch on Engineer's Control Panel on leading unit.
2. Depress deadman pedal.
3. Move reverse handle to Forward or Reverse position as required.

### MANUAL TRANSITION

### 1500 or 1600 HP Freight or Road Switcher Locomotives

When starting a train with a Road Switcher or a Freight locomotive equipped with manual transition, the selector handle should be in position 1. As the speed increases, the pointer on the speed-transition meter will move up to section 2 and the selector handle should be moved to position 2. This procedure should be followed in moving the selector handle to positions 3 and 4.

As locomotive speed decreases selector handle should be moved to position indicated on the transition scale. The selector handle may be moved to any motoring position regardless of the throttle position.

The speed range, for each Selector Handle Position, is marked on the Speed-Transition Meter or the Speed-Recorder Dial if used; and for various locomotive gearing is shown in the following table:

| Selector Handle Position | GEARING - MPH For Locomotive Maximum Speeds Of (4 Motor Equipment - 40 Inch Wheels) | | | | |
|---|---|---|---|---|---|
| | 60 | 65 | 75 | 80 | 92 |
| 1 | 0 - 15 | 0 - 17 | 0 - 19 | 0 - 21 | 0 - 24 |
| 2 | 15 - 21 | 17 - 23 | 19 - 27 | 21 - 29 | 24 - 33 |
| 3 | 21 - 44 | 23 - 49 | 27 - 55 | 29 - 60 | 33 - 68 |
| 4 | 44 - 65 | 49 - 65 | 55 - 75 | 60 - 80 | 68 - 92 |

## AUTOMATIC TRANSITION

When starting a train with a Road Switcher, Freight or Passenger locomotive equipped with automatic transition, move the reverse handle to forward position and then move the selector handle to position 4, which permits automatic transition to take place at predetermined locomotive speeds during acceleration or deceleration.

The approximate speeds at which the transition relays pick up, or at which the Engineer may manipulate the Selector Handle to enforce manual supervisory control over the automatic are as shown in the following tables:

## 1500 OR 1600 HP ROAD FREIGHT OR ROAD SWITCHER

| Transition or Selector Handle Position Move | GEARING - MPH For Locomotive Maximum Speed Of (4 Motor Equipment - 40 Inch Wheels) | | | | |
|---|---|---|---|---|---|
| | 60 | 65 | 75 | 80 | 92 |
| 1 - 2 | 15 | 17 | 19 | 21 | 24 |
| 2 - 3 | 21 | 23 | 27 | 29 | 33 |
| 3 - 4 | 44 | 49 | 55 | 60 | 68 |

## 2000 OR 2250 HP ROAD PASSENGER WITH MULTIPOINT SHUNTING

| Transition or Selector Handle Position Move | GEARING - MPH For Locomotive Maximum Speed Of (40 Inch Wheel) | | | |
|---|---|---|---|---|
| | 80 | 92 | 104 | 117 |
| 1 - 2 | 15 | 17 | 19 | 21 |
| 2 - 3 | 23 | 26 | 30 | 34 |
| 3 - 4 | 38 | 44 | 49 | 55 |

Note: The tables for Automatic Transition are Approximate speeds for manual operation guidance --- See maintenance instructions for actual transition speed relay settings.

## ACCELERATING A TRAIN WITH ROAD LOCOMOTIVE

Release the brakes and open throttle to Notch 1. The pointer on the loadmeter should show some movement. This brings in the motor contactors but does not increase Diesel engine speed and the locomotive should immediately start to move; if it does not, advance to Notch 2 or higher if necessary to get the train moving since damage to the traction motors will result if they remain stationary with power applied.

When the locomotive starts to move maintain the throttle in a notch which will keep the locomotive moving without acceleration until the train is stretched.

After the train is stretched, advance the throttle one notch at a time to increase speed. It is desirable to get trains up to speed as rapidly as possible, consistent with smooth operation, either on grades or on a level track, using the higher values of current as necessary to do this. During starting and acceleration, the loadmeter pointer may move into the high current zone for short periods of time. This is desirable in order to obtain maximum starting effort and speedy acceleration.

Notching off should, if possible, be done a notch at a time for smooth operation.

## STOPPING A TRAIN USING DYNAMIC BRAKE (If Used)

The dynamic brake is an arrangement of traction motors and generator-exciter for retarding the locomotive and train. The motors are reconnected as electric generators. The power thus produced is dissipated as heat in the fan-cooled resistor assembly in the roof hatch over the Diesel engine.

Since work is required to operate the motors as generators, a retarding effect is produced on the locomotive wheels as long as the train is in motion.

The operation and effect of the dynamic brake on the train is similar to that of the locomotive independent air brake in that braking effort is applied to the locomotive only. The same precautions for bunching the slack and for preventing slack "run out" are required.

The loadmeter shows the amount of traction motor current in dynamic braking as well as in motoring. Therefore, it is the key to dynamic brake operation, and the pointer position should be observed frequently while the dynamic brake is being used.

The inner scale marked "BRAKING" is used to indicate the pointer position during dynamic braking.

Continuous operation may be had for any pointer position within the white portion of the scale, except as shown in the dynamic braking limit table.

Any position of the pointer in the red portion of the scale indicates an overload which must be relieved immediately by retarding the selector handle to prevent possible damage to the motors and the resistor assembly.

A brake warning light, mounted on the instrument panel at the engineer's position, is arranged to light whenever a dynamic brake overload condition takes place on either the lead or trailing units. This light will turn off when the overload is relieved.

Braking limits must be observed during dynamic braking. The full amount of dynamic braking within the white portion of the loadmeter scale may be employed at all speeds up to 85 percent of the top speed for which the locomotive is geared. The maximum is 800 amperes and the corresponding pointer position on the loadmeter is opposite the numeral 8 on the outer scale.

At speeds above 85 percent the braking is limited to 600 amperes and the corresponding pointer position on the loadmeter is opposite the numeral 6 on the outer scale. Actual speeds corresponding to 85 percent of the top speed for various gearings are shown in the table below.

## DYNAMIC BRAKING LIMIT

| Top Speed Gearing | Restrict to 600 Amperes Above |
|---|---|
| 65 MPH | 55 MPH |
| 75 MPH | 64 MPH |
| 80 MPH | 68 MPH |
| 91 MPH | 78 MPH |
| 104 MPH | 88 MPH |
| 117 MPH | 100 MPH |

The operation of the dynamic brake is arranged for use only with the locomotive moving forward as viewed from the operating position since the selector handle is interlocked so that the reverse handle must be in the FORWARD position in order to obtain dynamic braking.

To apply dynamic braking, move the throttle to IDLE, see that the reverse handle is in FORWARD, move the selector handle to OFF and then to the right into the braking range. Observe that a slight movement of the loadmeter pointer takes place.

To bunch the train slack, advance the selector handle slightly into the braking range so that the loadmeter pointer will not indicate over 100 amperes. The corresponding pointer position is not more than halfway between 0 and 2 on the outer scale.

After the slack is bunched, advance the selector handle as required for the desired amount of braking. Make all handle movements slowly and with deliberation.

Do not exceed the limits on the loadmeter. If the brake warning light lights, retard the selector handle until the light goes out.

When making slowdowns, good judgement must be used in applying the dynamic brake soon enough to accomplish speed reduction in time. As the train speed decreases, the loadmeter pointer will move to the left. The selector handle may then be further advanced to keep the pointer close to the end of the white portion of the braking scale.

It is permissible to use the dynamic brake down to a standstill. However, at very low locomotive speed, the braking effort tapers off and a considerable period of time is required to reach a standstill on a level track.

It is also permissible to start from a standstill on a downgrade with the dynamic brake applied.

Where conditions of the train and the grade are severe, the maximum permissible dynamic braking may be insufficient to hold the desired train speed. If the speed increases, the loadmeter pointer will move to the right into the red portion of the braking scale and the brake warning light will light. It is then necessary to retard the selector handle to bring the loadmeter pointer out of the red portion and to turn off the warning light. An application of the automatic air brake must be made to regain control of the train speed.

To release the dynamic brake, retard the selector handle slowly. Pause at the position where the loadmeter pointer indicates 100 amperes to prevent slack "run out". Then, move the handle to OFF, and if desired, to the normal motoring position. A light application of the independent air brake may be made as the dynamic brake is released, as a further precaution against slack "run out".

A dynamic brake interlock is provided between the locomotive air brakes and the dynamic brake. When an automatic service application is made with the dynamic brake in operation, air pressure is automatically kept out of the locomotive brake cylinders to prevent possible sliding of the wheels.

When an emergency application occurs from any cause, the interlock is nullified and full air pressure is applied to the locomotive brake cylinders. In addition the dynamic brake is automatically cut off. When an emergency application is made the selector handle should be returned at once to OFF.

The independent air brake is not interlocked with the dynamic brake and is available for use at any time. However, to avoid sliding of the locomotive wheels, the independent air brake and the dynamic brake should never be applied simultaneously.

The dynamic brake may be cut out on any unit by turning the engine control switch on the Engine Control Panel to IDLE.

To avoid surges on the equipment and on the train, the dynamic brake cutout operation should only be made when the selector handle is in OFF. For the same reason, the dynamic brake should not be cut in on a unit except with the selector handle in OFF.

## DYNAMIC BRAKING WITH LEAD UNIT DOWN

When the engine of the lead unit is taken "off the line" by placing the engine control switch in IDLE or OFF position, there will be no dynamic braking available on the unit and the loadmeter will be inoperative. The dynamic brake on the trailing units may be continued in service and controlled from the lead unit but the sole guide to the presence of overload conditions will be the operation of the brake warning light. The selector handle should be manipulated so as to keep the light turned off.

To get dynamic braking on trailing units with the lead unit down, the following must be done:

1. Selector handle on lead unit must be in braking position. This will complete the circuit through 50A, 50AA potentiometer, 30J and 22 train line.

2. In order to energize 50A circuit:

   (a) Close 170 fuel pump switch on Engine Control Panel. This will close FPC contactor.

   (b) Close 172 MG breaker on Control Compartment Panel.

   (c) 136 main control positive breaker on the Control Compartment Panel must be closed.

However, in order to conserve the battery, open the fuel pump and crankcase exhauster breakers on the Control Compartment Panel.

### NORMAL STOPPING WITH A ROAD LOCOMOTIVE

Close the throttle to IDLE position and apply air brakes and if leaving the engineer's position, move the selector and reverse handles to OFF position.

### BRAKING WITH POWER

Under certain conditions, it is necessary to keep a train "stretched". In order to do this, the throttle must be reduced in accordance with the loadmeter maintaining the indicator in the continuous rating zone with the train brakes applied and locomotive brakes released. As the train speed decreases, the indicator will move to the right toward the high current zone in which case the throttle should be further reduced. The throttle should be in IDLE before the train comes to a dead stop.

On locomotives equipped with manual transition, the speed transition meter should be observed and the selector handle moved as indicated.

## ROAD SWITCHER LOCOMOTIVES

### BEFORE MOVING A TRAIN

1. Install brake valve handles and reverse lever.
2. Check for main reservoir pressure.
3. Have 70 pounds of control air pressure.
4. Make brake application, release handbrake.
5. The multiple-operation cutout cock on multiple-unit equipped locomotives, located in the cross-over pipe above the distributing valve must be closed (handle parallel with pipe) for single locomotive operation.
6. The dead engine cock located on the distributing valve must be in "live" position.
7. Test sanders.
8. Make air brake test.
9. Have at least 120° F water temperature, if possible, as shown on the Engine Control Panel gauge before notching up.

### PRELIMINARIES IN HANDLING A TRAIN WITH ROAD SWITCHER

1. Close generator field switch on Engineer's Control Panel.
2. Move reverse handle to Forward or Reverse position depending on direction desired.
3. Move selector handle to Position 1.

## ACCELERATING A TRAIN WITH A ROAD SWITCHER

Release the brakes and open throttle to Notch 1. The pointer on the loadmeter should show a slight movement. This brings in the motor contactors but does not increase Diesel engine speed and the locomotive should immediately start to move; if it does not, advance to Notch 2, or higher if necessary, to get the train moving since damage to the traction motors will result if they remain stationary with power applied.

When the locomotive starts to move maintain the throttle in a notch which will keep the locomotive moving without acceleration until the train is "stretched".

After the train is "stretched", advance the throttle one notch at a time to increase speed. It is desirable to get trains up to speed as rapidly as possible, consistent with smooth operation, either on grades or on a level track, using the higher values of current as necessary to do this.

During starting and acceleration, the loadmeter pointer may move into the high current zone for short periods of time. This is desirable in order to obtain maximum starting effort and speedy acceleration.

As the train speed increases, the pointer on the speed-transition meter will move up to Section 2 on the transition scale and the selector handle should then be moved to Position 2. This procedure should be followed in moving the selector handle to Positions 3 and 4.

As the locomotive speed decreases, the selector handle should be moved to the position indicated on the transition scale.

The selector handle may be moved to any motoring position regardless of the throttle position.

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## STOPPING A TRAIN WITH A ROAD SWITCHER

Close throttle to IDLE position and apply air brakes and if leaving engineer's position, move selector and reverse handles to OFF position.

## REVERSING LOCOMOTIVE

1. Bring locomotive to a full stop.
2. Move selector handle to No. 1 position.
3. Move reverse handle to reverse position.
4. Open throttle.

## SHUTTING DOWN DIESEL ENGINES

1. Open generator field switch located on Engineer's Control Panel.
2. Move engine control switch on Engine Control Panel to OFF position.
3. Open fuel pump switch on Engine Control Panel.
4. Release air brakes and apply hand brake.
5. Open all other switches on Engineer's Control Panel.
6. Open battery switch.

## THROTTLE HANDLING

All ALCO-GE locomotives of the 1500 or 1600 HP and 2000 or 2250 HP, both Road and Road Switcher types, incorporate an inherent feature in their control which provides throttle control of tractive effort. This feature presents two advantages: First, it affords the engineer the ability to control, by throttle notch position, the amount of tractive effort to be developed. Second, it provides a positive protection against excessive load current on the traction motors and generator.

The proper use of this feature offers much in improved train handling as well as protection to the electrical equipment. It is important therefore that the engineer thoroughly understand its proper use, since it does require slightly different throttle handling, than for other types of locomotives not so equipped.

### How It Works

For each throttle position a definite maximum load current and corresponding tractive effort is developed. The increase, as the throttle is advanced from one position to the next, is made immediately but smoothly. Since, however, the total tractive effort of the locomotive is divided into eight steps available on the eight throttle notches, it is necessary to advance all the way into the 8th notch in order to develop full tractive effort. Further, since maximum current is controlled, it is perfectly safe, so far as electrical or mechanical equipment in concerned, to advance the throttle rapidly into the 8th notch; in fact this is not only desirable, but necessary under certain starting conditions.

### How It Is Used

It is well understood that the worst treatment that can be given a traction motor is to allow it to stand at "stall" condition for any appreciable length of time with load current applied to it. It is therefore most important, having given due care to insure that the brakes are released and that train slack is out, to:

(1) Start the locomotive to move as quickly as possible; and

(2) Accelerate to a speed which will bring the loadmeter pointer down in the Green zone in a minimum time.

Therefore, in making a start, since there is no danger of excessive load current, the throttle should be advanced promptly to a notch that will start locomotive movement. If after starting, acceleration is too fast or until it is certain that all slack is out, the throttle may be backed off as required to maintain desired locomotive speed. As soon as the slack is out, the throttle may be advanced as fast as desired to suit operating conditions. It is good practice to hesitate at each notch position to allow the engine to come up to the new notch speed. This may be judged when the loadmeter pointer has come to rest at the new position.

### Starting Passenger or Light Trains

For normal starting of passenger and light trains, no appreciable difference in throttle handling will be noted from other types of equipment except the immediate response obtained for each throttle notch advance.

### Normal Starting of Heavy Freight Trains

Normally it is not necessary to "bunch" the slack. If the train is known to be stretched, as soon as the brakes are fully released, throttle should be advanced immediately to whatever notch is required to start movement, then adjusted up or down to suit desired operating condition bearing in mind desirability of accelerating the train to where the loadmeter registers in the Green zone in minimum time. For normal level grade starting, if no movement is obtained when the throttle has reached 5th or 6th notch, shut off throttle and recheck to insure that the brakes are fully released.

### For Starting Heavy Trains on Severe Grades

It is occasionally necessary to take as much as the 7th or 8th notch to make a start. The engineer must, of course, use due care in handling the train slack and to time his power application to insure that brakes are released. Having assured himself of slack and brake conditions, he should have no hesitancy in advancing the throttle quickly into even the 8th notch to get the train moving. While the load current will be high, the control protects against any damaging excess, and the important thing is to get the locomotive moving and thus keep to a minimum, the length of time during which heavy load current is applied to the motors before they start to turn.

## MISCELLANEOUS OPERATING INSTRUCTIONS

### FASTER AIR PUMPING

1. Generator field switch located on Engineer's Control Panel must be OFF.
2. Reverse handle must be in OFF position.
3. Selector handle must be in Position 1.
4. Open throttle to Notch 5 or below.

### CHANGING OPERATING ENDS ON ROAD LOCOMOTIVES

On end being cut out:

1. Make a 20 pound brake pipe reduction with the automatic brake valve, after which move the brake valve handle to Lap position.
2. Move the independent brake valve handle to Release position and observe that the brakes are still applied.
3. Close the brake pipe cutout cock (vertical position).
4. Place the rotair valve in either FRGT. LAP for a train of 51 cars or more or PASS. LAP for a train of 50 cars or less.
5. Move the automatic brake valve handle to Running position and remove both handles.
6. Place reverse handle in OFF position and remove. To do this it is necessary that the selector handle be in OFF position and the throttle in IDLE.
7. On the Engineer's Control Stand open control and generator field switches; leave fuel pump switch closed.

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On end being cut in:

1. Put reverse handle in place and leave in OFF position.
2. Insert automatic and independent brake valve handles.
3. Place rotair valve in PASS. for a train of 50 cars or less and FRGT. for a train of 51 cars or more.
4. Move independent brake valve handle to Application position.
5. Open brake pipe cutout cock.
6. Move automatic brake valve handle to Emergency position, then back to Lap.
7. When changing feed valve pressures, depress the independent brake valve handle in full Application position for about 8 seconds to avoid possibility of an overcharge.
8. Move automatic brake valve handle to Running or Release position.
9. Close control and fuel pump switches on the Engineer's Control Stand.
10. Open fuel pump switch on end being cut out.
11. Close generator field switch on Engineer's Control stand.
12. Place foot on deadman pedal and release independent brake.

### CHANGING OPERATING ENDS ON ROAD SWITCHER LOCOMOTIVES

On locomotive being cut out:

1. Make full service application with automatic brake valve.
2. Close double-heading cock.

3. The multiple operation cutout cock located in the crossover pipe above the distributing valve must be OPEN (crosswise with pipe).

4. Move automatic brake valve to Lap or Holding position and the independent brake valve to Running position.

5. Place reverse handle in OFF position and remove. To do this, it is necessary that the selector handle be in OFF position and the throttle in IDLE.

6. On the Engineer's Control Panel open the control and generator field switches leaving the fuel pump switch closed.

On locomotive being cut in:

1. Put reverse handle in place and leave in OFF position.

2. Move independent brake valve handle to application position.

3. Open double-heading cock.

4. Close the multiple-operation cutout cock (vertical).

5. Close the control and fuel pump switches on the Engineer's Control Panel.

6. Open the fuel pump switch on the locomotive being cut out.

7. Close the generator field switch.

## EMERGENCY ENGINE SHUT DOWN

Push in red stop button located on Engineer's Control Panel to shut down all engines simultaneously. To restart engines go to the Engine Control Panel on each of the coupled units and turn the engine control switch to OFF position. This must be done before any engine can be started. Start the engines in usual manner. Use the red stop button only in extreme emergency as all air compressors shut down when the Diesel engines are stopped. To shut off the flow of fuel from the fuel tank to the Diesel engine pull any one of the emergency fuel trip knobs.

## RUNNING THROUGH WATER

Do not exceed 2 or 3 MPH if there is water above the railhead. Do not pass through water over 4 inches above railhead.

## PASSING OVER RAILROAD CROSSINGS

The severe mechanical shocks received by traction motors when passing over railroad crossings at high speed may cause the brushes to bounce and flash over the traction motors. The throttle should be reduced to notch 5 or under before entering the crossing at high speed. This is not necessary at slow speeds.

## TAKING DIESEL ENGINE "OFF THE LINE"

1. Turn the engine control switch to OFF position.

2. Open the fuel pump switch on the Control Compartment Panel when using dynamic braking. Otherwise open the fuel pump switch on the Engine Control Panel.

## PUTTING DIESEL ENGINE "ON THE LINE"

1. Close fuel pump switch.

2. Turn engine control switch to IDLE position.

3. Wait until the three brusharms on the front of the governor stop moving. Ten seconds is usually sufficient time for the governor to reset.

4. Turn start switch on the Engine Control Panel clockwise to crank the engine. Hold in this position while cranking the engine until oil pressure shows on gauge, alarm stops and green light goes out.

5. Release start switch after alarm stops and light goes out. Releasing the start switch before the green light goes out will stop the engine and the above procedure will have to be repeated.

6. Turn engine control switch to Run pausing three seconds at each intermediate position so that engine loading will be gradual.

## PARTIAL LOAD OPERATION

The Diesel engine may be operated at partial load by moving the engine control switch to position 2, 4 or 6 regardless of throttle position.

Position 2, 4 or 6 correspond to throttle Notch 2, 4 or 6. After setting the engine control switch at any of these intermediate points, the Diesel engine speed will increase only up to that point although the throttle may be in a higher notch. The positioning of the engine control switch thereby controls or limits the output of the Diesel engine. This arrangement is advantageous when cooling down a "hot engine" or if low oil pressure is experienced.

## TOWING DEAD LOCOMOTIVE

(Brake Pipe Hose Only Connected)

In freezing weather, drain engine and steam generator water systems. Brake equipment on one or more "dead" units which are in multiple with a "live" leading unit should be set up the same as "live" trailing units. It is recommended that brake equipment on each unit of a "dead" multiple unit locomotive which is not in multiple with a "live" unit should be set up as a single "dead" unit.

### "A" UNIT

1. Close the brake pipe cutout cock and remove automatic brake valve handle in Running position.

2. Place dead engine cock in Dead position on D-24 control valve.

3. Place charging changeover cock in Passenger position on D-24 control valve.

4. Remove or keep independent brake valve handle in Release position.

5. Place rotair valve handle in Passenger position.

### "B" UNIT

1. Place dead engine cock in Dead position on D-24 control valve.

2. Open brake valve cutout cock (hostler's station).

3. Remove brake valve handle in Full Application position, then move brake valve stem to Release position, using Reverse side of brake valve handle.

4. Place charging changeover and control emergency cocks in Passenger position.

5. Close reducing valve cutout cock (hostler's station).

6. Open end cocks on actuating and application-release pipes on one end of unit.

### ROAD SWITCHER

1. Close double heading cock on brake valve pedestal.

2. Place automatic and independent brake valve handles in "running" position.

3. Place throttle in IDLE, selector and reverse handles in OFF position.

4. Place the multiple-operation cutout cock on locomotives equipped for multiple-unit operation in "Lead-Dead" position.

5. Place dead engine cock in "Dead" position.

6. Set safety valve on distributing valve for 25 psi.

## ENGINE OVERSPEED SWITCH

If the Diesel engine speed reaches 1110 ± 10 RPM, the overspeed switch will automatically shut down the engine by de-energizing governor clutch coil. This causes the fuel pump racks to move to the shut down position.

To reset overspeed switch:

1. Move engine control switch to OFF position.
2. Push in overspeed switch reset button.
3. Start engine and move engine control switch to Run. If the overspeed switch repeatedly trips on any unit, that unit may be operated at partial load by moving the engine control switch to the intermediate position necessary to keep it from tripping.

## REVERSER

If the reverser fails to operate, turn engine control switch to IDLE on the unit affected. Try moving the reverser by pressing on either of the magnet valve buttons.

If this is not effective, remove manual operating handle from clips on reverser frame. Insert handle in hole provided in casting on top of operating shaft and move to position corresponding with movement of train.

## TRACTION MOTOR CUTOUT SWITCH

A traction motor cutout switch, located in the contactor compartment, is provided which may be used to isolate a pair of traction motors.

In order to determine whether or not a traction motor is causing the ground relay to pick up, return throttle to IDLE, push ground relay reset button and turn traction motor cutout switch to cut out motors 1 and 4. With selector handle in Position 1, open throttle. If ground continues, return throttle to IDLE, reset ground relay and turn traction motor cutout switch to cut out motors 2 and 3.

If ground still continues, return throttle to IDLE, reset ground relay, then open ground relay cutout switch. Move locomotive no farther than necessary, observing for smoke and overheating of electrical equipment.

## GROUND RELAY

If a ground occurs in the main power circuit on any unit of a multiple-unit locomotive, alarm bells will ring on all units and the ground indicating light will light on the Engine Control Panel of the unit having the ground. On a single unit locomotive, the alarm bell will ring and the ground indicating light will light on the Engine Control Panel.

As the ground relay operates, a red indicator will appear at the bottom of the contact assembly. The Diesel engine will return to idling speed.

To reset the ground relay:

1. Turn engine control switch to IDLE position.
2. Push in ground relay reset button.
3. Turn engine control switch to RUN position, pausing three seconds at each intermediate position.

If ground relay continues to trip:

1. Turn engine control switch to IDLE.

## CIRCUIT BREAKERS

Circuit breakers are used in all control circuits which will trip and open whenever an overload occurs. Breakers, suitably identified, are located at the engineer's position and on the Control Compartment Panel.

If a circuit breaker should trip, the handle will be approximately midway, between ON and OFF. To reset, move handle to OFF position and then to ON position. In some cases it may be necessary to wait a few minutes before the breaker can be reset.

## GROUND RELAY CUTOUT SWITCH

The ground relay cutout switch, located in the Control Compartment, is used to cut out the action of the ground relay in the high voltage circuit.

## WHEEL SLIP WARNING BY LOADMETER

Normally wheel slip warning is given by the wheel slip relay system. The loadmeter may also be the engineer's warning of a wheel slip. Any sudden drop of loadmeter reading, not caused by a throttle reduction, is an indication of wheel slip.

## HAND BRAKE OPERATION

To apply the hand brake on a road locomotive, turn the wheel clockwise until the brake is fully applied.

To release, turn the wheel counterclockwise.

To apply the handbrake on a road switcher locomotive, engage the latching lever in back of the brake wheel and then turn the wheel in a counterclockwise direction until the brakes are fully applied.

To release the hand brake, turn the wheel counterclockwise about one-eighth of a turn; disengage the latching lever and release the wheel.

## JOURNAL BOX HEAT INDICATOR

Each journal box using roller bearings is equipped with a heat indicator located on either the upper or lower left corner of the box face. This device stores liquid and is held in place by a solder plug. Whenever the temperature inside the box reaches 220 F the plug melts and the heated liquid emits a strong pungent odor. The train should be stopped and the "hot box" located as this odor is noticed. An examination should be made to determine the cause and necessary precautions taken before moving the train.

## OPERATING WITH STEAM LOCOMOTIVE HELPER

Before using a steam locomotive as a helper, it should first be determined that the steam locomotive can pull its share of the tonnage at or above the rated speed of the Diesel locomotive as the tonnage rating of steam locomotives used in helper service is sometimes based on speeds below the continuous rated speed of the Diesel locomotive.

It therefore follows that if the helper locomotive cannot pull its share of the tonnage of the train which is in excess of the continuous tonnage rating of the Diesel locomotive, the Diesel locomotive will endeavor to pull more than its share which may result in eventual damage to the equipment.

When operating with a helper the loadmeter should be carefully watched as overloading of the Diesel locomotive will be indicated by the loadmeter indicator hand moving into the high current range. The Diesel locomotive throttle should be reduced allowing the train speed to drop until the helper locomotive assumes its share of the tonnage and then set the Diesel locomotive throttle in the position that allows the loadmeter indicating hand to remain in the upper part of the continuous rating zone.

## PC SWITCH

The pneumatic control switch (PCS) is an air operated electric switch located in the right side of the nose on road locomotives and in the back hood section of road switchers (if used). Any penalty application of air brakes such as emergency application of brakes, deadman application of brakes, train control application (if used) and locomotive overspeed (if used) will trip this switch returning the Diesel engine to idle. The switch is reset automatically when the throttle is returned to idle and the brake recovered.

## RECOVERY OF BRAKE AFTER PENALTY APPLICATION

1. Place brake valve in Lap, Service or Emergency.
2. Close throttle to IDLE.
3. Depress deadman pedal.
4. Allow application pipe to build up to main reservoir pressure.
5. Release brakes.

## DOUBLE HEADING BEHIND STEAM LOCOMOTIVE

When preparing for double heading a Diesel locomotive behind a steam locomotive, make a full service application, close the brake pipe cutout cock, but leave the rotair valve in FRGT. or PASS. position depending upon the service required. Brakes are then controlled from the steam locomotive but the engineer on the second unit can make an emergency application by moving the automatic brake valve handle to emergency position, and can release the brakes on the Diesel locomotive by depressing the independent brake valve handle.

## OPERATING WITH LEAD UNIT DOWN

1. Close battery switch on lead unit.
2. Close main control 136 positive and negative breakers on the lead unit Control Compartment Panel.
3. Close control breaker 181 on the lead unit Engineer's Control Stand.
4. Close fuel pump breaker 169 on the lead unit Engineer's Control Stand.
5. Close fuel pump switch 170 on the lead unit Engine Control Panel.
6. There will be no dynamic braking.

In case of a dead battery on a leading unit, the locomotive may be operated from the "lead" unit after closing the battery switch and opening Auxiliary Generator, Auxiliary Generator Field, Crankcase Exhauster, MG Set, Fuel Pump, Blower Generator Field and Blower Generator breakers on the Control Compartment Panel; Fuel Pump and Control Breakers on Engineer's Control Stand; and Fuel Pump Switch on the Engine Control Panel. If the next trailing unit is an "A" unit, close the Fuel Pump and Control breakers on the Engineer's Control Stand and if a "B" unit with hostler's station, close both hostler's breakers. If a hostler's stand is not provided, the unit becomes inoperative. If a third unit is used, all breakers must be in normal operating position.

## TROUBLE SHOOTING

### 1. IF ENGINE FAILS TO START:

a. Starting procedure not correctly followed. Check over starting details.

b. Engine does not rotate up to firing speed. See Item 2.

c. Engine rotates fast enough but does not fire. See Item 4.

### 2. IF ENGINE ROTATES VERY SLOWLY OR NOT AT ALL WHEN STARTING SWITCH IS TURNED AND LIGHTS GO DIM:

a. Low battery. Shut down engine.

b. Internal engine condition. Shut down engine.

c. Engine very cold. In this case ONLY, try again to start after heating water system with steam.

d. Be sure turning device is disengaged.

### 3. IF ENGINE FAILS TO ROTATE WHEN STARTING SWITCH IS TURNED AND LIGHTS REMAIN BRIGHT:

a. See that starting contactors GS1, GS2 close.

b. Interlocks on P21 and S21 contactors not making good contact.

c. One or more control circuit breakers tripped. Reset circuit breaker or breakers.

### 4. IF ENGINE ROTATES WHEN STARTING SWITCH IS TURNED BUT FAILS TO START:

a. Lack of fuel oil pressure.

b. Fuel injection pumps cut out.

c. Fuel pump racks not out. This is caused by insufficient time delay between putting engine control switch to IDLE and turning the starting switch. Refer to "Starting Engine".

d. Governor may be inoperative. Check for loose plug connection and dirt in oil.

e. See that Diesel engine overspeed button is "IN".

f. Water in fuel.

5. IF ENGINE SHUTS DOWN:

a. Lack of fuel oil pressure.

b. Overspeed device tripped. Not properly adjusted. If the overspeed device repeatedly trips out on any unit, that unit may be operated on reduced power by moving the engine control knob to the intermediate position necessary to keep it from tripping.

c. Lack of lubricating oil pressure. See Item 6.

d. Governor may be inoperative. See Item 4c.

e. Lack of governor oil pressure.

f. Check for loose plug connections on governor tachometer.

6. IF ENGINE IDLES OR SHUTS DOWN DUE TO LOW LUBRICATING OIL PRESSURE:

a. Lubricating oil filters clogged.

b. Lubricating oil strainer clogged.

c. Low oil level in crankcase. Check and if found under LOW mark, do not try to restart Diesel engine.

d. Broken lubricating oil line. Shut down engine.

e. Lubricating oil too hot or diluted.

f. Pressure regulating valve stuck or backed off. Tap lightly or remove cap and turn down adjusting nut.

7. IF ENGINE OVERHEATS:

a. Radiator cooling fan not rotating, Try manual control.

b. Radiator shutters not open.

c. Insufficient water.

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8. IF ENGINE FAILS TO INCREASE SPEED WHEN NOTCHING UP:

a. Check for engine control switch being in IDLE position.

b. Control breaker OFF on Engineer's Control Panel.

c. Ground relay has operated.

d. Engine has low lubricating oil pressure.

9. IF ENGINE FAILS TO MAINTAIN SPEED UNDER NORMAL LOADING:

a. Fuel filters clogged.

b. Turbosupercharger air pressure low.

c. Cylinders cut out or not firing.

d. Incorrect fuel limit adjustment on the governor.

10. IF AUXILIARY GENERATOR AMMETER DOES NOT SHOW CHARGE:

a. Auxiliary generator field circuit breaker tripped.

b. Auxiliary generator circuit breaker tripped.

11. IF ENGINE FAILS TO LOAD:

a. Control circuit breaker not closed.

b. Generator field circuit breaker not closed.

c. Engine control switch in IDLE.

d. Control air pressure low. Check control and main reservoir air pressures, control air feed valve and control air cutout cock.

e. Reverse handle not fully thrown.

f. Safety control foot pedal not depressed.

g. Starting contactor GS 1 or GS 2 stuck closed.

h. PC switch has not reset.

i. EF or GF contactors not closed.

j. If rear unit or units fail to take power, check control line jumpers to be sure they are in place and properly locked. Change jumpers if necessary.

k. MG set circuit breaker tripped.

## 12. IF ENGINE SHOWS DEFICIENT OUTPUT:

a. Engine control switch not in Run Position.

b. GF contactor not closed.

c. Nozzle stuck in closed position (generally indicated by hot fuel pump). Cut out cylinder affected.

d. Lack of fuel oil pressure.

e. Load meter out of calibration.

f. Engine speed low (due to governor adjustment). DO NOT TAMPER WITH ADJUSTMENT.

g. Locomotive control fails to change from series-parallel shunt (selector position 2) to parallel (selector position 3).

Check main contactors in electrical control compartment.

Contactors S1 and S21 should be in series-parallel and P1, P2, P21 and P22 should be in parallel.

## 13. IF REVERSER FAILS TO OPERATE:

a. Reverse handle in OFF position.

b. Control circuit breaker not closed.

c. Control air pressure low. Check control and main reservoir air pressures, control air feed valve, and control air cutout cock.

d. Refer to section on "Reverser".

## 14. IF HEADLIGHT GOES OUT:

a. Check headlight circuit breaker.

b. Test headlight lamp. To replace loosen four wing nuts on reflector case in nose and tilt reflector inward to get at lamp.

## 15. IF TRACTION MOTOR BLOWERS STOP:

The alarm bells will ring in all units and the ground relay trip light will light in the unit affected but the red target on the ground relay will not show.

a. Check blower generator circuit breaker.

b. Check blower generator field circuit breaker.

c. Check motor-generator circuit breaker.

If any of these breakers are tripped, reset them.

If the blower generator circuit breaker trips and the engine is operating above idle speed, the blower generator field circuit breaker should be tripped before resetting the blower generator circuit breaker. Reset the blower generator field circuit breaker last.

If the circuit breakers are not tripped or if the blower motors do not run when the breakers are reset, the engine should be taken "off the line" immediately and train tonnage reduced accordingly.

The engine may be run at IDLE speed to protect against freezing, but otherwise it should be shut down.

A traction motor blower failure should trip the blower generator circuit breaker and operate the alarm system. However, periodic inspections should be made to see that the blowers are operating.

A single traction motor blower failure necessitates the cutting out of the locomotive unit.

## 16. IF INJECTION TROUBLE SHOULD DEVELOP:

a. A fuel injection pump may be cut out by means of a cutout latch. Push in the pump rack and flip the latch over to prevent movement of the spring-loaded operating lever. In this position the pump will not deliver fuel.

A pump should be cut out for the following reasons:

a. A broken fuel line to a cylinder.

b. Stuck valve.

c. A single pump considerably hotter than the others.

d. Blown exhaust gasket.

e. A pump stuck or pounding.

f. A broken pump.

No more than two pumps may be cut out at any one time. If more than two pumps are cut out, the action of the governor may be abnormal.

## 17. IF THE TURBOSUPERCHARGER OPERATES ABNORMALLY:

The engine should be shut down and the train tonnage reduced accordingly. Abnormal operation would be caused by excessive vibration or a stuck rotor shaft.

## ELESCO STEAM GENERATOR

### BEFORE STARTING

1. Auxiliary generator on locomotive should be running and main air reservoir should have at least 60 psi pressure.

2. Check position of all valves. Valves with cross handles should be fully opened. Valves with round handles should be closed, excepting water glass valves (2) and (6).

3. Turn handles (7) on fuel oil strainer one full turn.

4. Close main switch by moving handle (1) to the "ON" position.

### STARTING STEAM GENERATOR:

1. If no water shows in the glass run feedwater pump (10) on air as follows:

   a. Close pump steam valve (23).

   b. Open pump air valve (9).

   c. Open steam separator air vent cock (3) while filling.

2. When water reaches top of water glass, place control switch (12) in starting position. Push "START" button (14) and motor will run.

3. Continue to operate feedwater pump on air until water remains in water glass, then shut pump air valve (9) and open pump steam valve (23).

4. Close steam separator air vent cock (3).

5. Push and release differential pressure valve water line snubber (65) two or three times to insure full opening in pressure line to differential pressure valve.

6. Place control switch (12) in running position. The steam generator will fire.

7. As steam generator comes up to pressure, water will tend to rise. Use manual blowdown valve (25) to keep about one-half glass of water.

## TO FEED STEAM TO TRAINLINE:

Steam generator pressure should be 275 psi shown on pressure gauge (16) red hand before proceeding.

1. Set lever of steam flow control valve (22) in position 2.

2. Open remote control steam shutoff solenoid valve (5) by pulling lever down to latched position.

3. Slowly open main steam line shutoff valve (18) to full open position.

4. If required, use manual blowdown valve (25) to keep about one-half glass of water.

5. Loosen wing lock nut on stem of steam pressure reducing valve (21) and adjust this valve to give the desired reducing valve setting. After reducing valve is set, tighten wing lock nut.

6. For high trainline steam demands during cold weather, move lever of steam flow control valve (22) very slowly to position 4.

7. When trainline is fully charged, trainline pressure will be about reducing valve pressure. These pressures show on steam gauge (17).

## PARALLELING ELESCO STEAM GENERATORS:

1. Set steam flow control valve levers (22) in same position.

2. Adjust reducing valve (21) to have about same pressures, white hand on steam pressure gauge (17) within 5 to 10 psi.

## RUNNING ATTENTION

1. Operate remote control solenoid blowdown valve (11) about five seconds every one-half hour by means of separator blowdown switch on remote control panel in locomotive cab.

## TO SHUT DOWN STEAM GENERATOR:

1. Close steam shutoff valve (18) and open manual blowdown valve (25) slowly and blow for five seconds.

2. Push "STOP" button (13); the motor will continue to run but at a reduced speed for cool-down period.

3. When steam pressure has dropped to about 50 psi, motor will automatically stop. After motor has stopped, move main switch handle (1) to "OFF" position.

## TO SHUT DOWN STEAM GENERATOR ENROUTE DURING COLD WEATHER:

1. Close steam line shutoff valve (18).

2. Push "STOP" button (13).

3. Open manual blowdown valve (25) and circulating pump drain valve (8) wide to thoroughly blow down generator. After generator is blown down leave these valves "cracked" open.

4. Open oil regulating valve drain (4), differential pressure valve steam line drain (19), differential pressure valve water line drain (20), and feedwater pump steam line drain (24). Close water suction line stop valve (28) and open feed pump suction line drain valve (27).

5. Open steam generator heater valve (15). This connects steam generator to trainline, allowing steam from trainline to enter to prevent freezing.

6. Move main switch handle (1) to "OFF" position.

## TO STORE STEAM GENERATOR DURING FREEZING WEATHER:

1. Start and run steam generator at maximum steam pressure for at least 15 minutes with main steam shutoff valve (18) closed.

2. Stop electric motor by pulling main switch to "OFF" position.

3. Close feedwater pump steam valve (23).

4. Open circulating pump drain valve (8) and manual blowdown valve (25) wide. Hot water will escape from steam generator at full force.

5. Close feed pump suction line valve (28). Remove pipe cap from washout line and open washout valve (26) inserted in this line.

6. Open feedwater pump air valve (9) and run pump on air at idling speed for about 20 minutes.

7. While steam pressure is still existing in generator, open drain valves (19), (20), (4), and also open valve (24) after feed pump has been stopped. Open manual by-pass of steam reducing valve (30). Disconnect both steam pressure gauges at steam generator gauge panel.

NOTE (a) -

In case there is no source of electric power to operate the steam generator, but if steam under pressure is available, open valve (15) and warm steam generator thoroughly while having blowdown valve (25) opened slightly. After steam generator has been heated up by steam, close valve (25) almost fully and wait until a steam pressure of about 250 psi has been reached in generator. Leave generator at this pressure condition for at least 20 minutes; then close valve (15) and open valves (8) and (25) wide. Proceed as outlined in the above items, 5 to 7 inclusive.

NOTE (b) -

If both electric power and steam are not available, remove plug (29) from inlet header and connect 3/4" air hose to inlet header and blow thoroughly with valves (8) and (25) open.

Proceed as outlined in the above items, 5 to 7 inclusive.

## TROUBLE SHOOTING

| NORMAL | TROUBLE | ACTION |
|---|---|---|
| **1. WHEN MAIN SWITCH IS CLOSED** | | |
| a. Pressure gage lamp, water glass lamp, Electric Eye indicating lamp all light. | If one of these lamps does not light. | Check for burned out lamp. |
| | If none of these lamps light. | Check for tripped circuit breakers. Check for blown fuses in motor control cabinet. |
| b. Alarm bell should not ring | If alarm bell rings. | Push "STOP" button in. Check control switch. It should be in "Starting" position. |
| **2. AFTER PUSHING "START" BUTTON WITH CONTROL SWITCH IN "STARTING" POSITION** | | |
| a. "STOP" button is automatically released. | If "STOP" button does not release. | Check "START" and "STOP" buttons for defects. |
| b. Motor starts and comes up to speed driving circulating pump, fuel oil pump and blower. | If motor does not start. | Check "Reset" of motor overload relay in motor control cabinet. Reset if necessary by pushing reset button down. Check circuit breakers and reset if found tripped. Check for blown fuses in motor cabinet. |
| c. "START" indicating lamp lights. | If "START" indicating lamp does not light and motor is running. | Check for burned out lamp. |
| d. Alarm bell should not ring. | If alarm bell rings. | Check control switch. It should be in "Starting" position. |
| **3. STEAM GENERATOR NOT RUNNING** | | |
| a. Circulating pump pressure gage white hand should indicate 30 to 40 psi greater than red hand. The 30 to 40 psi difference in these pressures is called "Differential pressure". It shows steam generator has proper water circulation. | If there is no differential pressure or pressure is low or unsteady. | Check for proper amount of water in steam generator (approximately 1/2 glass) and add water if necessary. Push plunger on snubber in differential pressure valve water line to clean snubber. Check circulating pump discharge line strainer. It may require cleaning. |
| b. Fuel oil pump pressure gage, red hand, should indicate 250 psi. | If fuel oil pump pressure is low or no pressure. | Check for oil in pump suction line by inspecting flow in sight glass. Turn handle on fuel oil pump suction line strainer to clean strainer. Pressure gage may be defective. Check to see that fuel oil pump shaft is rotating. Check belt tension. Fuel oil relief valve may be stuck open. |
| | If fuel oil pump pressure is too high. | Fuel oil relief valve may be stuck closed. Fuel return line may be plugged. Pressure gage may be defective. |

| NORMAL | TROUBLE | ACTION |
|---|---|---|
| c. Main oil solenoid valve opens after differential pressure is established. It makes a definite "click" when it opens. | If main oil solenoid valve does not open. | Check for defective valve. |
| **4. CONTROL SWITCH IS PLACED IN "RUNNING" POSITION TO MAKE STEAM GENERATOR FIRE** | | |
| a. "Burner On" lamp lights. | If "Burner On" lamp does not light and steam generator fires. | Check for burned out lamp. |
| | If "Burner On" lamp does not light and alarm bell rings. | Check items under "Action" 3. a. |
| b. Small burner oil solenoid valve opens. This will be indicated by fuel oil pressure gage, red hand dropping slightly. Ignition converter runs for about five seconds providing spark after which it cuts out. As soon as fire is established Electric Eye indicating lamp goes out. | If steam generator does not fire within five seconds, shut down will occur and alarm bell will ring. | Restart steam generator. Check fuel oil pump pressure and when control switch is placed in "Running" position note slight drop in fuel oil pump pressure which indicates that small burner oil solenoid valve has opened. If no drop in pressure, check for defective small burner oil solenoid valve or main oil solenoid valve. Check small burner nozzle for plugging. Check through burner peep hole for proper spark. Check air damper and rigging to see that it is in low position. |
| | If no spark or improper spark. | Check electric wiring between ignition transformer and electrodes. Check for dirty or defective electrodes. Gap between electrodes should be 3/16". Check to see if ignition converter is running. |
| | If steam generator fires for about five seconds, Electric Eye indicating light remains on and then a shutdown occurs with both "Start" and "Burner On" indicating lights going out and alarm bell ringing. | Clean Electric Eye shutter sight glasses and check electric eye tubes. |

| NORMAL | TROUBLE | ACTION |
|---|---|---|
| c. Steam generator operates on small burner until steam pressure, red hand on pressure gage is about 30 psi. The large burner solenoid valve then opens and large burner comes on. This is indicated by pressure showing on white hand of fuel oil gage. Oil pressure of large burner starts to fall off when steam pressure reaches 260 psi and oil pressure drops to zero when steam pressure reaches 270 psi. When steam pressure reaches 290 psi, small burner automatically shuts down and "Burner On" indicating light goes out. | If large burner oil pressure, white hand on fuel oil gage, does not start to decrease at about 260 psi steam pressure and large burner remains on until "Burner On" indicating lamp goes out. | Check for defective oil regulating valve bellows. This is indicated by steam leak at lower part of assembly. |
| 5. STEAM GENERATOR OPERATING WITH TRAINLINE SHUTOFF VALVE CLOSED | | |
| | If steam generator shuts down when cycling, alarm bell rings with both the "Start" and "Burner On" indicating lights going out and motor running at reduced speed. | Place Control Switch in "Starting" position. This will cut out alarm bell. Restart steam generator. Place Control Switch in "Running" position. Also check items under "Action" 4.b. |
| a. Steam generator fire is automatically cut out when steam pressure reaches 290 psi. When steam pressure drops to 275 psi it refires. Small burner going on and off at short intervals is called "Cycling". | If alarm bell rings with "Start" indicating light on and "Burner On" indicating light out. | Check items under "Action" 3.a. Check feedwater pump steam valve for full open. Check water glass on steam separator for indication that water in steam separator may be foaming. If so, give good blowdown using manual blowdown valve. |
| | If smoke shows at stack when refiring and then stack clears. | Check small burner air damper and electrodes. Burner is not igniting as quickly as it should. |

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| NORMAL | TROUBLE | ACTION |
|---|---|---|
| 6. STEAM GENERATOR FEEDING STEAM TO TRAINLINE | | |
| a. With low steam demand, steam generator may cycle as in "5". With normal steam demand both the small and large burners will be on. The large burner pressure, white hand on fuel oil gage, is controlled by the oil regulating valve and it varies with steam demand. | If steam generator stops firing, alarm bell rings with "Start" indicating light on and "Burner On" indicating light out. | Check differential pressure, water in glass, water storage tank, feedwater pump and its piping. Make sure feedwater pump steam valve is wide open. Check feedwater pump action. It may be sucking air through leaky cover on water treatment tank. Check items under "Action" 5.a. Check treatment tank drain valve. It should be closed. |
| | If steam generator shuts down, alarm bell rings, "Start" and "Burner On" indicating lights go out, and motor runs at reduced speed. | Check for fuel oil pump pressure. With steam generator off, clean Electric Eye shutter sight glasses. Also check items under "Action" 4.b. |
| | If steam generator shuts down, alarm bell rings, both indicating lights go out and motor shuts down. | Check for tripped circuit breakers. Check items under "Action" 2.b. |
| | If smoke shows at stack with large burner on. | Check action of air damper and rigging. Check blower belt drive. |

## VAPOR-CLARKSON STEAM GENERATOR

## OK 4630 - OK 4616

### BEFORE STARTING

On OK models, the valves designated by odd numbers must be OPEN during normal operation of the steam generator. Valves designated by even numbers must be CLOSED during normal operation of the steam generator. Normally open valves are fitted with a cross type handle; normally closed valves are fitted with the standard round handle. These designations apply only to the OK series steam generators.

1. Make certain that the following valves are OPEN:

    Atomizing Air Shutoff Valve (1)

    Coil Shutoff Valve (3)

    Return Water Outlet Valve (9)

    Steam Admission Valve (11 to Trainline Pressure Gauge (224)

    Steam Admission Valve (13) to Water By-Pass Regulator (111)

    Three-Way Washout Valve (17)

    Water By-Pass Regulator Shutoff Valve (19)

    Water Supply Stop Valve (21)

2. Be sure that the following valves are CLOSED:

    Coil Blowdown Valve (2)

    Layover Connection Shutoff Valve (6)

    Manual Water By-Pass Valve (8)

    Steam Admission Valve (10) to Radiation (217)

    Washout Inlet Valves (14) and (16)

    Water Pump Test Valve (18)

    Water Drain Valves (20) and (22)

3. See that both the overload reset button (106) and the stack switch (109) reset button are "IN". The overload reset button is located inside the control panel on the magnetic overload relay.

### TO FILL

1. Open the atomizing air shutoff valve (1) and fill-test valve (4); latch open the separator blowdown valve (12) to drain the steam separator. Close the separator blowdown valve when the separator is completely drained.
2. Close the main switch and turn the control switch (102) to FILL.
3. While the coils are filling see that spark (220) is available for ignition. Check ALL valves.
4. When water discharges from the fill-test valve (4) turn the control switch (102) to OFF and close the fill-test valve.

**NOTE:** If the coils are empty it will take about five minutes to fill the steam generator with water.

### TO START

**CAUTION:** Do not start the steam generator unless the coils are filled.

1. Latch open the separator blowdown valve (12) and turn the control switch (102) to RUN. For easy starting, be sure the control switch has been OFF long enough for the motor to come to a full stop.
2. Close the separator blowdown valve when the generator steam pressure gauge (212) registers 50 psi.
3. Open the separator blowdown valve several times for three to five second intervals during the first few minutes of operation.
4. Set the water by-pass regulator (111) to the required train line pressure.

5. After the trainline is coupled, open the remote control trainline shutoff valve (7) by depressing the reset lever (7a) and then open the stop and check valve (15).

**NOTES:**

1. Check the return water flow after the steam generator has settled down to a steady output. On 3000 pound units the return water flow indicator (218) should cycle from 4 to 12 times a minute; on 1600 pound units it should cycle from 4 to 8 times a minute.
2. If the steam generator does not start or function properly, check all valves to see that they are open or closed as indicated in piping diagram for OK and DSK steam generators.
3. The steam generator should come up to full operating pressure in one or two minutes; it may take 10 or 15 minutes to build up the required operating steam pressure in the trainline.

## RUNNING ATTENTION

1. Open the separator blowdown valve (12) for five seconds at least once every hour.
2. Turn the handle on the fuel filter (206) during stops. At the same time, turn the handle on the treatment injector filter (225), where this method of water treatment is used.

## TO SHUT DOWN THE STEAM GENERATOR

For short stops it is only necessary to close the stop and check valve (15). The fire will cycle and maintain operating pressure in the steam generator. For terminal stops, proceed as follows:

1. Close the stop and check valve (15) and the remote control trainline shutoff valve (7).

2. Set the water by-pass regulator (111) to maximum output. When the generator steam pressure gauge (212) registers 200 psi turn the control switch (102) to OFF.
3. Open the coil blowdown valve (2). When the generator pressure drops to 75 psi, close the valve.
4. Open the separator blowdown valve (12) and blow down the steam separator (221) with the remaining pressure. Close the separator blowdown valve.
5. Fill the coils with water.
6. Close the atomizing air shutoff valve (1) and open the main switch.

**NOTE:** When starting, do not omit draining the steam separator, opening the fill-test valve, and again filling the steam generator with water. If the coils are already full, it will only take a moment for water to discharge from the fill-test valve.

## FREEZING WEATHER PRECAUTIONS

The inlet valve (10) to the radiation (217) should be opened when operating during severe weather.

If a locomotive with a multiple installation does not have all of its steam generators in operation, open the coil blowdown valve (2), the layover connection shutoff valve (6) and the inlet valve (10) to the radiation on idle steam generators.

**CAUTION:** Layover connection shutoff valve (6) must be closed when trainline shutoff valve (7) is closed to cut a car out of a train.

If a locomotive is left standing out of service, operate one of the steam generators or make a connection to the yard steam line. In extremely cold weather the water pump (230) and steam generator controls should be given additional protection against freezing.

If no steam is available, thoroughly drain the steam generator. Open the drain valves (20) and (22), the water pump test valve (18), the coil blowdown valve (2), the separator blowdown valve (12) and the coil shutoff valve (3). Break the pipe connections where necessary to completely drain the piping. Turn the water pump by hand to clear it of water, or blow it out with compressed air. Remove the cover of the water treatment or water strainer tank (234) and make sure it is drained.

## TROUBLE SHOOTING

If one of the protective switches (magnetic overload relay, coil blowdown valve switch, stack switch high temperature contacts) operates to shut down the steam generator, the alarm will ring and the "boiler off" signal will flash on the engineer's control panel and engine control panel.

Turn the control switch (102) to OFF and use the following instructions as a guide in locating the trouble.

### MOTOR AND BURNER SHUT DOWN DURING OPERATION

1. Blown fuses or tripped circuit breakers: The alarm will not ring and instrument lights will go out. The circuit breaker or breakers are located on the control compartment panel and in some cases one is mounted in the main switch box near the steam generator. Check these breakers as well as the control fuses in the steam generator control cabinet. The OK series of steam generators has a test lamp and fuse clips wired inside the control cabinet. Use this fuse test clip and test lamp to check the fuses.

2. Overload reset button (106) "out". The alarm will ring; the instrument lights will remain on. Turn the control switch (102) OFF: check for hot blower (202) or water pump (230) bearings and for poorly adjusted pulley belts. On OK units check the setting of the belt tension adjuster. Push the overload reset button "IN".

3. Stack switch (109) reset button "out": The high temperature contacts in the stack switch are open; the alarm will ring and the instrument lights will remain on. Turn the control switch (102) to OFF: open the separator blowdown valve (12) and drain the steam separator (221). Close the separator blowdown valve, push in the stack switch reset button, refill the coils with water and then start the steam generator.

4. Coil blowdown valve (2) partially open: The alarm will ring, the instrument lights will remain on. Be sure the locking pin on the coil blowdown valve handle is properly seated in the closed position.

### MOTOR STARTS BUT BURNER DOES NOT

If the fire fails to light, the low temperature contacts on the stack switch (109) will not close and after a 45 second time delay the outfire relay will open the circuit to shut down the steam generator. The alarm will ring and the instrument lights will remain on. Turn the control switch (102) OFF and check the following list for possible causes for the burner failure.

1. Ignition failure: Turn control switch to RUN; no spark visible through the peep hole glass, or spark is of low intensity. If an ignition fuse is blown or if the current flow is broken for any other reason, the ammeter in the ignition circuit on OK units registers zero when the ammeter test button is pressed in. If the ammeter registers below normal, the spark plug electrodes are dirty or too far apart. If the ammeter registers above normal the electrodes are too close together or the ignition circuit is grounded.

   Check the ignition fuses; on OK units use the test lamp and clips installed in the control cabinet for that purpose. Tighten loose cable connections and replace chafed or broken wire which may be breaking or grounding the circuit.

2. Low atomizing air pressure (201): The air switch (101) on OK units opens and breaks the circuit to the fuel solenoid valve (104), which then stops the flow

of fuel to the sprayhead (105). On DSK units, low air pressure will fail to lift the diaphragm in the fuel sprayhead (105); the needle valve remains closed and prevents the admission of fuel to the firepot.

Be sure the sir admission valve is fully open. Clean the strainer screen in the atomizing air line and drain the atomizing air pressure regulator (100). If the low atomizing air pressure persists, tighten the adjusting screw at the top of the air pressure regulator to increase the atomizing pressure.

3. Low fuel manifold pressure (208): Turn the handle on the suction line fuel filter (206) several times. A slight suction leak may cause the manifold pressure to build up slowly; put the control switch (102) on FILL to bleed the fuel line and bring the manifold pressure up to normal.

4. Low fuel nozzle pressure (207): Lack of water causes the servo-fuel control (108) to limit the supply of fuel entering the nozzle. If the water supply is almost completely stopped, the cam plate may come down far enough to actuate the cutout switch on the servo and close the fuel solenoid valve (104).

Be sure that the pump belts have proper tension, the water pump test valve (18) is closed, the cover on the water treatment or strainer tank (234) is tight, the three-way washout valve (17) is fully open, and that the drain valves (20) and (22) are tightly closed.

Open and close the water by-pass regulator (111) adjusting handle several times to free the regulator from possible sediment. If the water pressure gauge (229) still registers low, close the water by-pass regulator shutoff valve (19). This closes the water by-pass line and permits all of the feed water to flow to the servo-fuel control (108); the steam generator will start at once if the by-pass regulator is causing the trouble. Set and manually regulate the trainline steam pressure by adjusting the manual water by-pass valve (8).

High feed water temperature or leaky water line connections may cause the water pump (230) to become air or vapor bound. Violent fluctuation of the water pressure gauge needle indicates this condition. Tighten leaky water line connections and bleed the line by opening the water pump test valve (18). Allow water to flow from this valve until no air or vapor bubbles are evident in the water.

## IRREGULAR TRAINLINE PRESSURE

1. Burner cycles off and on: Insuffient water delivery causes the steam generator to run in superheat; the steam temperature limit control (110) operates to protect the coils against overheating. Check the water pump output as instructed in the preceding paragraphs.

2. Safety valves blow; Shut down the steam generator. Lower the trainline pressure setting on the adjusting handle of the water by-pass regulator (111) and start the steam generator again. If the safety valves (107) continue to pop, close the water by-pass regulator shutoff valve (19) and manually regulate the trainline steam pressure by opening and adjusting the manual water by-pass valve (8).

## REMOTE CONTROL EQUIPMENT (If used)

The remote control panel is located on the fireman's side of the locomotive cab. Mounted on it are a master switch to make the panel operative, and push-button switches to operate the separator blowdown valve (12) and the remote control trainline shutoff valve (7). A trainline steam pressure gauge is mounted on the panel.

A soot blower switch is also provided. It is to be used only when a steam generator of the CFK type is included in the installation.

The remote control trainline shutoff valve (7) can be closed from the cab; it must be opened manually, however. Depress the reset lever (7a) on the trainline shutoff valve (7) to the position marked "open".

ITEMS TO REPORT:

1. Water pressure greater than 450 psi at any time.
2. Excessive stack temperature.
3. Fluctuation of the fuel manifold pressure.
4. Frequent cycling of the burner.
5. Water flow indicator not cycling.
6. Water by-pass regulator inoperative.
7. Faulty operation of the steam generator for any reason.

## VAPOR-CLARKSON STEAM GENERATOR

## DRK 4530 - DRK 4516

### BEFORE STARTING

1. Make certain that the following valves are OPEN:

   Atomizing Air Shutoff Valve (1)
   Coil Shutoff Valve (16)
   Water Supply Stop Valve (33)
   Water By-Pass Regulator Shutoff Valve (39)
   Return Water Outlet Valve (51)
   Steam Shutoff Valve to the Water By-Pass Regulator
   Steam Shutoff Valves to the Steam Pressure Gauges

2. Be sure that the following valves are CLOSED:

   Washout Inlet Valves (14)
   Coil Blowdown Valve (17)
   Water Pump Test Valve (30)
   Stop and Check Valve (46)
   Manual Water By-Pass Valve (40)
   Manual Trainline Stop Valve (43)
   Drain Valves (54)

3. See that both the overload reset button (12) and the stack switch (5) reset button are "IN". If a thermal overload is used the reset button is located on the exterior of the control panel. If a magnetic overload relay is used, the reset button is located inside the control panel on the relay itself.

### TO FILL

1. Open the atomizing air shutoff valve (1), fill-test valve (50), and latch open separator blowdown valve (53) to drain the steam separator. Close the separator blowdown valve when the separator is completely drained.
2. Check the stack switch (5) reset button and overload reset button (12).
3. Close the main switch and turn the control switch (20) to FILL.
4. While the coils are filling see that spark is available for ignition. Check ALL valves.
5. When water discharges from the fill-test valve (50) turn the control switch (20) to OFF and close the fill-test valve.

NOTE: If the coils are empty it will take about five minutes to fill the steam generator with water.

### TO START

CAUTION: Do not start the steam generator unless the coils are filled.

1. Latch open the separator blowdown valve (53), and turn the control switch (20) to RUN.
2. Close the separator blowdown valve (53) when the generator steam pressure gauge (49) registers 50 psi.
3. Open the separator blowdown valve several times for three to five second intervals during the first few minutes of operation.
4. Set the water by-pass regulator (38) to the required trainline pressure.

5. After the trainline is coupled open the stop and check valve (46). Open the remote control trainline shutoff valve (42) by depressing the latch and then open the manual trainline stop valve (43).

NOTES:

1. Check the return water flow after the steam generator has been operating long enough to have settled down to a steady output. On 4530 steam generators the return water flow indicator (35) should cycle from four to twelve times a minute. On 4516 steam generators the return water flow indicator should cycle from four to eight times a minute.
2. If the steam generator does not start or function properly, check all valves to see that they are correctly open or closed.
3. The steam generator should come up to full operating pressure in one or two minutes; it may take 10 or 15 minutes to build up the required operating steam pressure in the trainline.

## RUNNING ATTENTION

1. Open the separator blowdown valve (53) for five seconds at least once every hour.
2. Turn the handle on the fuel filter during stops. At the same time, turn the handle on the filter for the water treatment injector where this method of water treatment is used.

## TO SHUT DOWN THE STEAM GENERATOR

For short stops it is only necessary to close the stop and check valve (46). The fire will cycle and maintain operating pressure in the steam generator. For terminal stops, proceed as follows:

1. Close the stop and check valve (46), the remote control trainline shutoff valve (42) and the manual trainline stop valve.

2. Set the water by-pass regulator (38) at maximum output. When the generator steam pressure gauge registers 200 psi turn the control switch (20) to OFF.
3. Open the coil blowdown valve (17). When the generator pressure drops to 75 psi close the valve.
4. Open the separator blowdown valve (53) and blow down the steam separator (48) with the remaining pressure. Close the blowdown valve.
5. Open the fill-test valve (50) and turn the control switch (20) to FILL. When water discharges from the fill-test valve, turn the control switch to OFF and close the valve.
6. Close the atomizing air shutoff valve (1) and open the main switch.

NOTE: When starting again, drain the steam separator, open the fill-test valve, and fill the steam generator with water. If the coils are already full, it will only take a moment for water to discharge from the fill-test valve.

## FREEZING WEATHER PRECAUTIONS

In severe weather, open the inlet valve to the radiation inside winterizing cabinets while the steam generator is in operation. During layovers, open the inlet valve whenever the temperature drops below freezing.

If a locomotive with a multiple installation does not have all of its steam generators in operation, open the coil blowdown valve (17) and the layover shutoff valve on idle steam generators, whether equipped with winterizing cabinets or not.

If a locomotive is left standing out of service, operate one of the steam generators or make a connection to the yard steam line. In extremely cold weather the water pump (29) and the generator controls should be given additional protection against freezing.

If no steam at all is available, thoroughly drain the steam generator. Open the drain valve (54) on the water treatment tank, the water pump test valve (30), the coil blowdown valve (17), the separator blowdown valve (53) and the coil shutoff valve (16). Break the pipe connections where necessary to completely drain the piping. Turn the water pump by hand to clear it of water, or blow it out with compressed air. Remove the cover of the water treatment or water strainer tank (34) and make sure it is drained.

## TROUBLE SHOOTING

If one of the protective switches (magnetic overload relay or thermal overload switch, coil blowdown valve switch, stack switch high temperature contacts or low temperature outfire contacts) operates to shut down the steam generator the alarm will ring and the "boiler off" signal will flash on the engineer's control panel and engine control panel.

Turn the control switch (20) OFF and use the following instructions as a guide in locating the trouble.

### MOTOR AND BURNER SHUT DOWN DURING OPERATION

1. Blown fuses or tripped circuit breakers: The alarm will not ring and instrument lights will go out. The circuit breaker or breakers are located on the control compartment panel and in some cases one is mounted in the main switch box near the steam generator. Check these breakers as well as the control fuses in the steam generator control cabinet.
2. Overload reset button "out". The alarm will ring, the instrument lights will remain on. Where a thermal overload switch is used, the reset button is located on the exterior of the control panel. Where a magnetic overload relay is used, the reset button is found inside the control cabinet on the relay itself. Turn the control switch (20) OFF: check for hot blower (11) or water pump (29) bearings and for tight or loose pulley belts.
3. Stack switch reset button "out": The alarm will ring, the instrument lights will remain on; the high temperature contacts in the stack switch (5) are open. Turn the control switch (20) OFF; open the separator blowdown valve (53) and drain the steam separator (48). Close the separator blowdown valve, push in the stack switch reset button, refill the coils with water, and then start the steam generator.
4. Coil blowdown valve partially open: The alarm will ring, the instrument lights will remain on. Be sure the locking pin on the coil blowdown valve (17) handle is properly seated in the closed position.

### MOTOR STARTS BUT BURNER DOES NOT

If the fire fails to light, the outfire contacts on the stack switch will not close, and after a 45 second time delay the outfire relay will open the circuit to shut down the steam generator. The alarm will ring and the instrument lights will remain on. Turn the control switch (20) OFF and check the following list for possible causes for the burner failure.

1. Ignition failure: No spark is visible through the peep hole glass. Check the ignition circuit fuses in the steam generator control cabinet. Tighten loose ignition cable connections and replace chafed or broken wire which may be breaking or grounding the ignition circuit.
2. Low atomizing air pressure: Low air pressure will fail to lift the diaphragm in the fuel spray head (7); the needle valve to the nozzle remains closed and prevents the admission of fuel to the firepot. Be sure the air admission valve is fully open. Clean the strainer screens at the air pressure reducing valve and in the air line.
3. Low fuel manifold pressure: Turn the handle on the suction line fuel filter (26) several times. A

slight suction leak may cause the manifold pressure to build up slowly; put the control switch (20) on fill to bleed the fuel line and bring the manifold pressure up to normal.

4. Low fuel nozzle pressure: Lack of water causes the servo-fuel control (19) to limit the supply of fuel entering the nozzle. If the water supply is almost completely stopped, the servo may come down far enough to actuate the cutout switch and close the air solenoid valve (3) to shut off the atomizing air.

Be sure that the water pump test valve (30) is closed, that the water strainers (6) are clean, that the cover on the water treatment or strainer tank (34) is tight, that the three-way washout valve (55) is correctly positioned and that the drain valves (54) are tightly closed.

Free the water by-pass regulator (38) from possible sediment by opening and closing the adjusting handle. If this has no effect, close the water by-pass regulator shutoff valve (39); the feed water then flows directly to the servo-fuel control (19), and the steam generator will start at once if the by-pass regulator is at fault. Regulate the trainline pressure by adjusting the manual water by-pass valve (40).

High feed water temperature or leaky water line connections may cause the water pump (29) to become air or vapor bound. Violent fluctuation of the water pressure gauge (18) needle indicates this condition. Tighten leaky water line connections and bleed the line by opening the water pump test valve (30). Allow water to flow from this valve until no air or vapor bubbles are evident in the water.

## IRREGULAR TRAINLINE PRESSURE

1. Burner cycles off and on: Insufficient water delivery causes the steam generator to run in superheat; the steam temperature limit control (23) operates to protect the coils against overheating. Check the water pump output as instructed in the preceding paragraphs.

2. Safety valves blow: Shut down the steam generator. Lower the trainline pressure setting on the adjusting handle of the water by-pass regulator (38) and start the generator again. If the safety valves (47) continue to pop, close the water by-pass regulator shutoff valve (39) and manually regulate the trainline steam pressure by opening and adjusting the manual water by-pass valve (40).

## REMOTE CONTROL EQUIPMENT (If used)

The remote control panel is located on the fireman's side of the locomotive cab. Mounted on it are a master switch to make the panel operative, push-button switches to operate the separator blowdown valve (53), a remote control trainline shutoff valve (42) and a trainline steam pressure gauge.

The remote control trainline shutoff valve (42) can be closed from the cab. It must be opened manually, however. Depress the reset latch on the automatic shutoff valve (42) to the position marked "open", and then open the manual trainline shutoff valve (43).

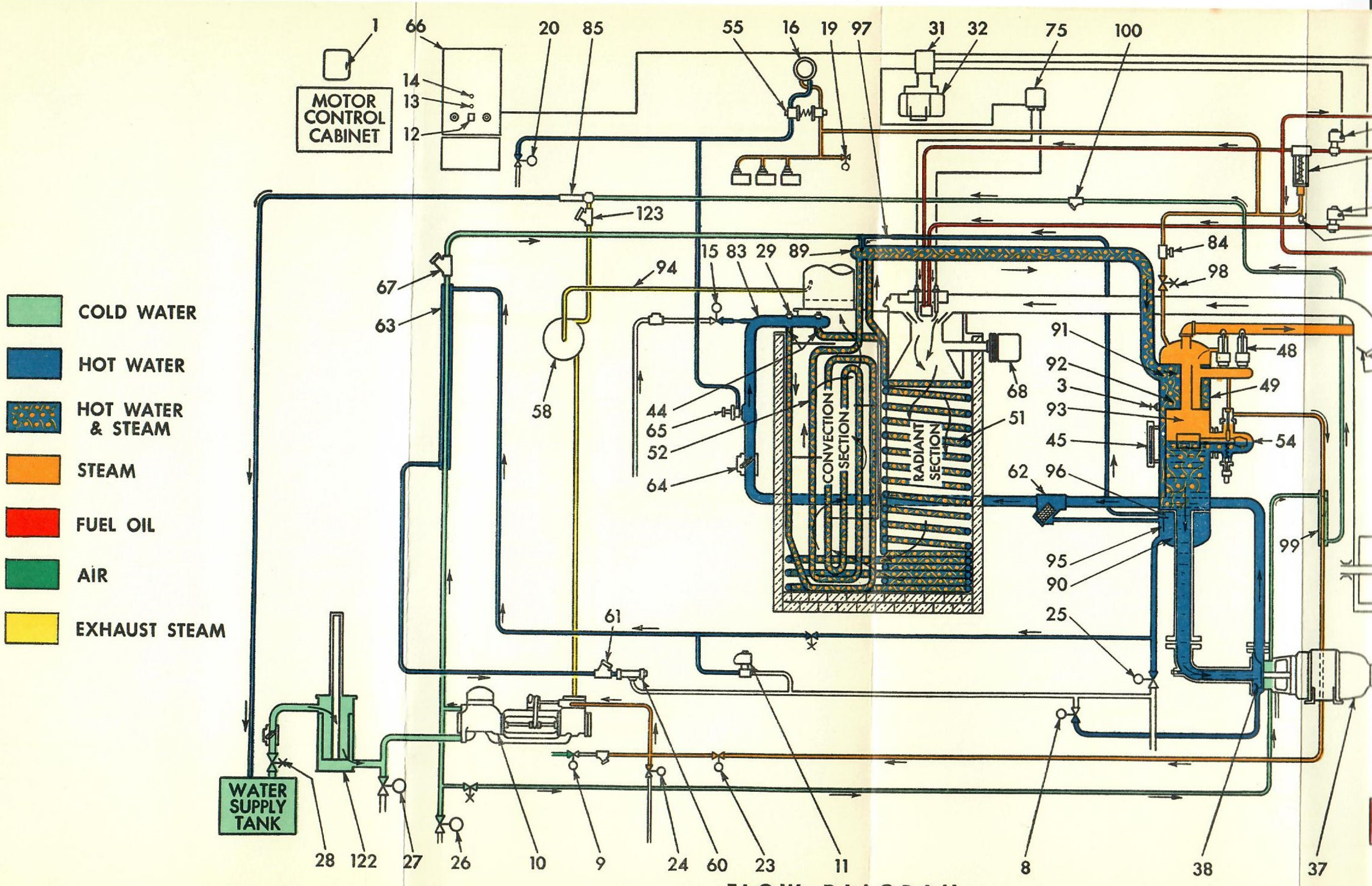
The soot blower switch is to be used only when a steam generator of the CFK type is included in the installation. The steam admission valve to the soot blowers must be left open in order to blow soot by remote control.

## ITEMS TO REPORT

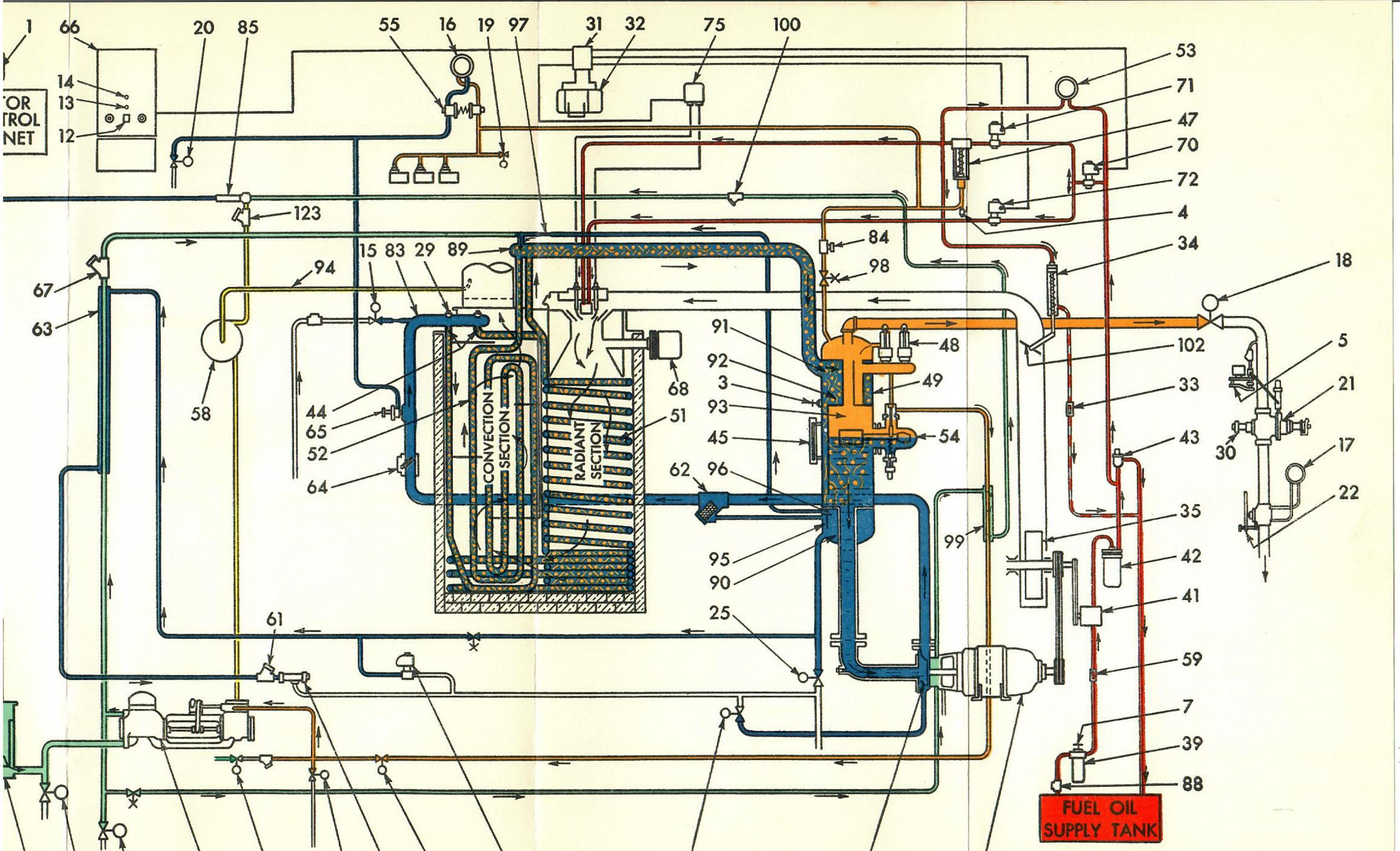
1. Water pressure greater than 450 psi at any time.
2. Excessive stack temperature.
3. Fluctuation of the fuel manifold gauge.
4. Frequent cycling of the burner off and on.
5. Water flow indicator not cycling.
6. Water by-pass regulator inoperative.
7. Improper function of the steam generator for any reason.

## NOTES

| | |
|---|---|
| 🟩 | COLD WATER |
| 🟦 | HOT WATER |
| ▨ | HOT WATER & STEAM |
| 🟧 | STEAM |
| 🟥 | FUEL OIL |
| 🟩 | AIR |
| 🟨 | EXHAUST STEA |


1
66
20
85
55
16
19
97
31
32
75
100
MOTOR CONTROL CABINET
14
13
12
123
15
83
29
89
84
98
94
67
63
58
44
65
52
64
CONVECTION SECTION
RADIANT SECTION
68
91
92
3
93
45
62
96
48
49
54
51
99
95
90
25
61
COLD WATER
HOT WATER
HOT WATER & STEAM
STEAM
FUEL OIL
AIR
EXHAUST STEAM
WATER SUPPLY TANK
28
122
27
26
10
9
24
60
23
11
8
38
37

FLOW DIAGRAM


1
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72
4
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OR
TROL
NET
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123
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98
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89
94
67
63
58
91
92
3
93
45
48
49
54
102
5
33
21
43
30
17
22
44
65
52
64
68
51
CONVECTION SECTION
RADIANT SECTION
62
96
95
90
99
35
42
41
25
61
59
7
39
88
FUEL OIL SUPPLY TANK
122
27
26
10
9
24
60
23
11
8
38
37

FLOW DIAGRAM

## KEY TO IDENTIFICATION SYMBOLS

**VALVES**

**Valves designated by odd numbers must be OPEN during normal operation of the steam generator. Valves designated by even numbers must be CLOSED during normal operation of the steam generator.**

**Normally open valves are fitted with a cross type handle; normally closed valves are fitted with the standard round handle. These designations apply only to the OK series steam generators.**

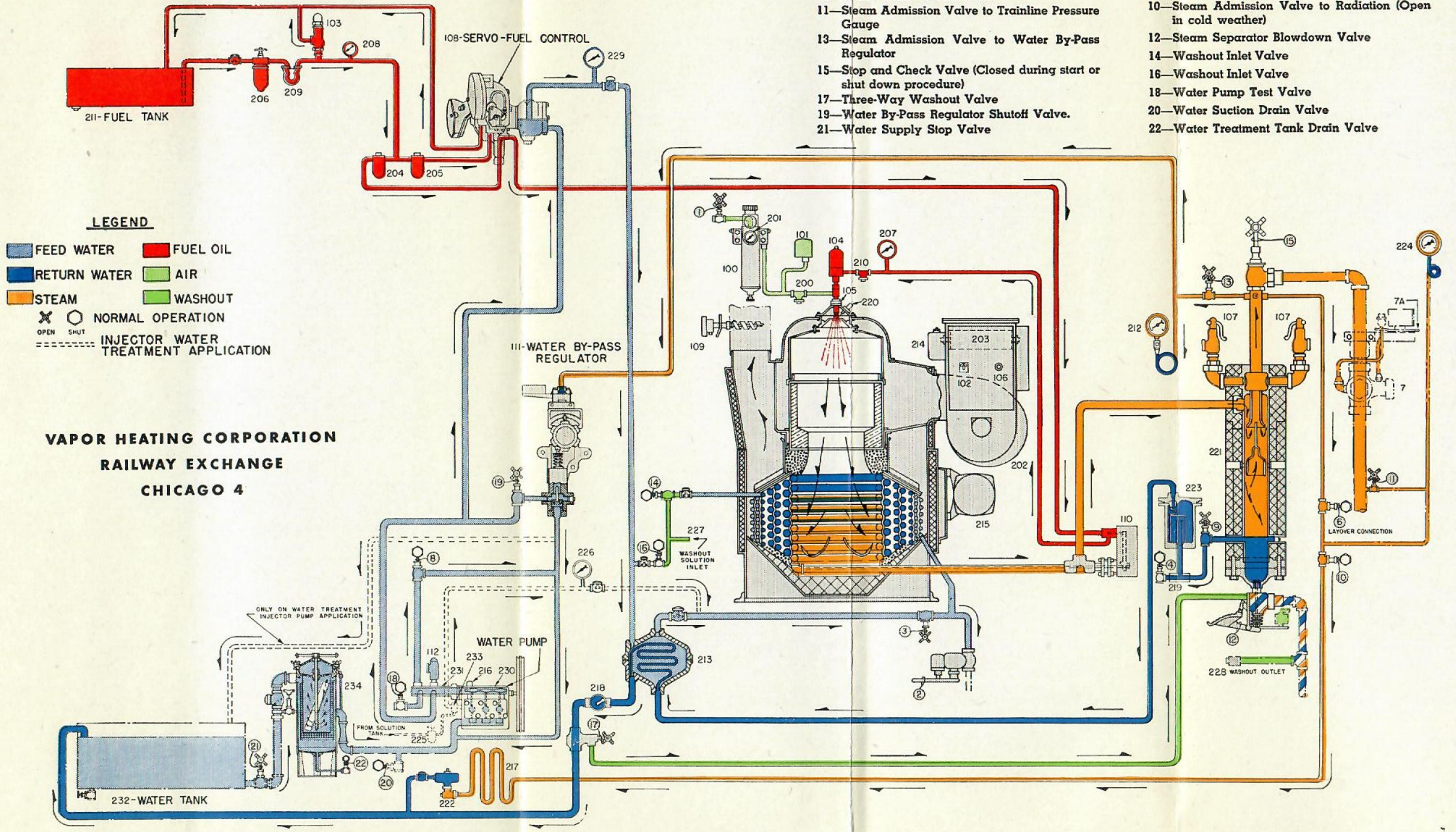
**The following valves must be OPEN during normal operation of the steam generator:**

1—Atomizing Air Shutoff Valve
3—Coil Shutoff Valve
7—Remote Control Trainline Shutoff Valve
7a—Reset Lever
9—Return Water Outlet Valve
11—Steam Admission Valve to Trainline Pressure Gauge
13—Steam Admission Valve to Water By-Pass Regulator
15—Stop and Check Valve (Closed during start or shut down procedure)
17—Three-Way Washout Valve
19—Water By-Pass Regulator Shutoff Valve.
21—Water Supply Stop Valve

**The following valves must be CLOSED during normal operation of the steam generator:**

2—Coil Blowdown Valve and Switch
4—Fill-Test Valve
6—Layover Connection Shutoff Valve
8—Manual Water By-Pass Valve
10—Steam Admission Valve to Radiation (Open in cold weather)
12—Steam Separator Blowdown Valve
14—Washout Inlet Valve
16—Washout Inlet Valve
18—Water Pump Test Valve
20—Water Suction Drain Valve
22—Water Treatment Tank Drain Valve

**VAPOR HEATING CORPORATION**
**RAILWAY EXCHANGE**
**CHICAGO 4**


LEGEND
▨ FEED WATER
🟥 FUEL OIL
🟦 RETURN WATER
🟩 AIR
🟧 STEAM
🟩 WASHOUT
✕ ○ NORMAL OPERATION
OPEN SHUT
INJECTOR WATER TREATMENT APPLICATION
211-FUEL TANK
206
209
103
208
204
205
108-SERVO-FUEL CONTROL
229
111-WATER BY-PASS REGULATOR
⑲
①
201
100
101
200
104
105
220
207
210
109
214
203
102
106
202
215
110
⑭
⑯
227
WASHOUT SOLUTION INLET
226
ONLY ON WATER TREATMENT INJECTOR PUMP APPLICATION
⑧
112
WATER PUMP
233
231
216
230
234
⑱
FROM SOLUTION TANK
225
㉑
㉒
⑳
232-WATER TANK
222
217
218
⑰
213
③
②
212
⑬
⑮
224
107
107
7A
7
221
223
⑨
④
219
⑪
⑥
LAYOVER CONNECTION
⑩
⑫
228 WASHOUT OUTLET

Schematic Piping Diagram, OK-4630 and OK-4616 Series Vapor-Clarkson Steam Generator.

100—
101—
102—
103—
104—
105—
106—
107—
108—
109—
110—
111—
112—

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221—
222—
223—
224—
225—
226—
227—
228—
229—
230—
231—
232—
233—
234—

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# KEY TO IDENTIFICATION SYMBOLS

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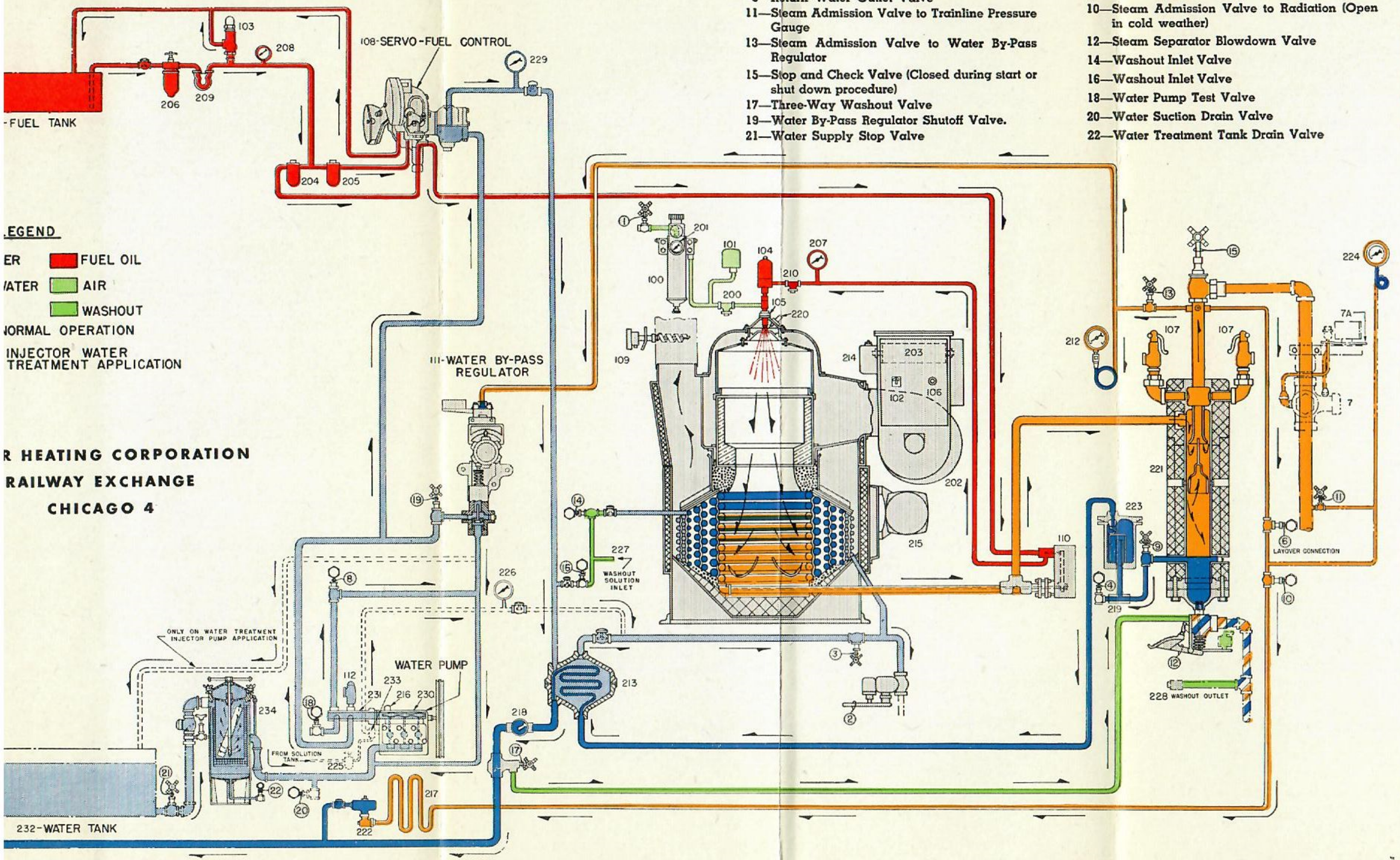
13—Steam Admission Valve to Water By-Pass Regulator
15—Stop and Check Valve (Closed during start or shut down procedure)
17—Three-Way Washout Valve
19—Water By-Pass Regulator Shutoff Valve.
21—Water Supply Stop Valve

The following valves must be CLOSED during normal operation of the steam generator:

2—Coil Blowdown Valve and Switch
4—Fill-Test Valve
6—Layover Connection Shutoff Valve
8—Manual Water By-Pass Valve
10—Steam Admission Valve to Radiation (Open in cold weather)
12—Steam Separator Blowdown Valve
14—Washout Inlet Valve
16—Washout Inlet Valve
18—Water Pump Test Valve
20—Water Suction Drain Valve
22—Water Treatment Tank Drain Valve

## CONTROLS

100—Atomizing Air Pressure Regulator
101—Atomizing Air Switch
102—Control Switch
103—Fuel Pressure Regulator
104—Fuel Solenoid Valve
105—Fuel Spray Head
106—Overload Reset Button, Motor
107—Safety Valves
108—Servo-Fuel Control and Switch
109—Stack Switch
110—Steam Temperature Limit Control
111—Water By-Pass Regulator and Switch
112—Water Pressure Relief Valve


LEGEND
ER
🟥 FUEL OIL
ATER
AIR
WASHOUT
ORMAL OPERATION
INJECTOR WATER TREATMENT APPLICATION
FUEL TANK
206
209
103
208
204
205
108-SERVO-FUEL CONTROL
229
111-WATER BY-PASS REGULATOR
⑲
⑧
ONLY ON WATER TREATMENT INJECTOR PUMP APPLICATION
234
㉑
㉒
⑳
FROM SOLUTION TANK
225
232-WATER TANK
112
⑱
WATER PUMP
233
231
216
230
226
222
217
218
⑰
213
①
201
101
104
207
100
200
210
105
220
109
214
203
102
106
202
215
⑭
⑯
227
WASHOUT SOLUTION INLET
③
②
110
212
⑬
⑮
107
107
221
223
⑨
④
219
⑫
228 WASHOUT OUTLET
224
7A
7
⑪
⑥
LAYOVER CONNECTION
⑩

R HEATING CORPORATION
RAILWAY EXCHANGE
CHICAGO 4

## APPURTENANCES

200—Atomizing Air Strainer
201—Atomizing Air Pressure Gauge
202—Blower
203—Damper
204—Fuel Filter (Fuel pressure line)
205—Fuel Filter (Servo actuating line)
206—Fuel Filter (Suction line)
207—Fuel Nozzle Pressure Gauge
208—Fuel Pressure Gauge (At fuel pressure regulator)
209—Fuel Pump
210—Fuel Strainer
211—Fuel Tank
212—Generator Steam Pressure Gauge
213—Heat Exchanger
214—Ignition Transformer
215—Motor Converter
216—Oil Filler Cap
217—Radiation
218—Return Water Flow Indicator
219—Return Water Strainer
220—Spark Plugs
221—Steam Separator
222—Steam Trap (Radiation)
223—Steam Trap (Return water line)
224—Trainline Steam Pressure Gauge
225—Treatment Injector Filter
226—Treatment Injector Gauge
227—Washout Solution Inlet
228—Washout Solution Outlet
229—Water Pressure Gauge
230—Water Pump
231—Water Strainer Manifold
232—Water Tank
233—Water Treatment Injector Pump
234—Water Treatment Tank (Strainer tank only if injector system is used)

Schematic Piping Diagram, OK-4630 and OK-4616 Series Vapor-Clarkson Steam Generator.

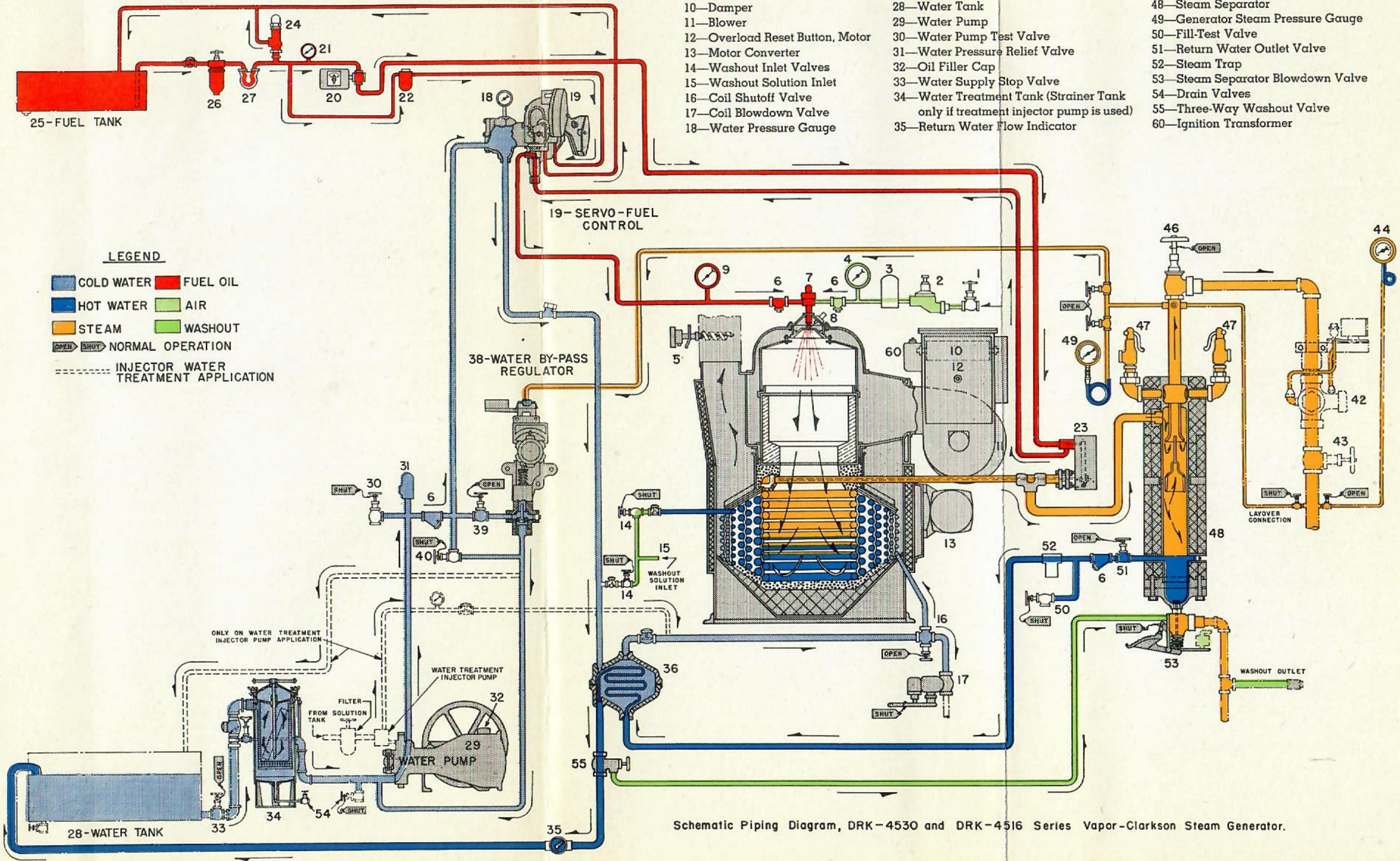
# VAPOR HEATING CORPORATION

RAILWAY EXCHANGE

CHICAGO 4

## KEY TO IDENTIFICATION SYMBOLS

1—Atomizing Air Shutoff Valve
2—Air Pressure Reducing Valve
3—Air Solenoid Valve
4—Air Pressure Gauge
5—Stack Switch
6—Strainers
7—Fuel Spray Head
8—Spark Plugs
9—Fuel Nozzle Pressure Gauge
10—Damper
11—Blower
12—Overload Reset Button, Motor
13—Motor Converter
14—Washout Inlet Valves
15—Washout Solution Inlet
16—Coil Shutoff Valve
17—Coil Blowdown Valve
18—Water Pressure Gauge
19—Servo-Fuel Control
20—Control Switch
21—Fuel Manifold Pressure Gauge
22—Fuel Filter (pressure line)
23—Steam Temperature Limit Control
24—Fuel Pressure Regulator
25—Fuel Tank
26—Fuel Filter (suction line)
27—Fuel Pump
28—Water Tank
29—Water Pump
30—Water Pump Test Valve
31—Water Pressure Relief Valve
32—Oil Filler Cap
33—Water Supply Stop Valve
34—Water Treatment Tank (Strainer Tank only if treatment injector pump is used)
35—Return Water Flow Indicator
36—Heat Exchanger
38—Water By-Pass Regulator
39—Shutoff Valve, By-Pass Regulator
40—Manual Water By-Pass Valve
42—Remote Control Trainline Shutoff Valve
43—Manual Trainline Stop Valve
44—Trainline Steam Pressure Gauge
46—Stop and Check Valve
47—Safety Valves
48—Steam Separator
49—Generator Steam Pressure Gauge
50—Fill-Test Valve
51—Return Water Outlet Valve
52—Steam Trap
53—Steam Separator Blowdown Valve
54—Drain Valves
55—Three-Way Washout Valve
60—Ignition Transformer


25-FUEL TANK
26
27
24
21
20
22
18
19
19-SERVO-FUEL CONTROL
LEGEND
COLD WATER
FUEL OIL
HOT WATER
AIR
STEAM
WASHOUT
OPEN SHUT NORMAL OPERATION
INJECTOR WATER TREATMENT APPLICATION
38-WATER BY-PASS REGULATOR
9
6
7
6
4
3
2
1
8
5
60
10
12
OPEN
46
44
47
47
49
42
43
23
SHUT
OPEN
LAYOVER CONNECTION
48
31
30
SHUT
6
OPEN
39
SHUT
40
SHUT
14
15
WASHOUT SOLUTION INLET
SHUT
14
13
52
OPEN
6
51
50
SHUT
SHUT
53
WASHOUT OUTLET
16
OPEN
17
SHUT
36
ONLY ON WATER TREATMENT INJECTOR PUMP APPLICATION
WATER TREATMENT INJECTOR PUMP
FILTER
FROM SOLUTION TANK
32
29
WATER PUMP
55
OPEN
34
54
SHUT
33
28-WATER TANK
35

Schematic Piping Diagram, DRK-4530 and DRK-4516 Series Vapor-Clarkson Steam Generator.

## LOCOMOTIVE DATA

Distinction is made between locomotive types where necessary. Otherwise figures cover all types of locomotives.

| | Road Switcher | Freight | Passenger |
|---|---|---|---|
| **Horsepower** | 1500 | 1500 | 2000 |
| **Max. Speed and Gear Ratio** | 65-74/18 | 65-74/18 | 80-64/19 |
| | 75-65/18 | 75-65/18 | 90-62/21 |
| | | 80-64/19 | 100-60/23 |
| | | | 117-58/25 |
| **Min. Radius Curvature** | 100 ft. | 274 ft. | 274 ft. |
| **Max. Track Curvature** | - | 21 deg. | 21 deg. |
| **Wheel Base** | 39' 4" | 36' 6" | 49' 8" |
| **Wheel Base** (each truck rigid) | 9' 4" | 9' 4" | 15' 6" |
| **Wheel Diameter** | 40" | 40" | 40" |
| **Journal Size** | 6½" x 12" | 6½" x 12" | 6½" x 12" |
| **Traction Motors** | 4 | 4 | 4 |
| **Brake Equipment** (W.A.B. Schedule) | 6 DS | 24 RL | 24 RL |
| **Max. Overall Dimensions** | | | |
| Height | 14' 5" | | |
| "A" Unit | | 14' 10" | 14' 11" |
| "B" Unit | | 14' 4½" | 14' 8" |
| Width | 10' 0" | | |
| "A" Unit | | 10' 6½" | 10' 6½" |
| "B" Unit | | 10' 6½" | 10' 6½" |
| Length Inside Knuckles | 55' 5-3/4" | | |
| "A" Unit | | 51' 6" | 65' 8" |
| "B" Unit | | 50' 2" | 63' 6" |

| Supplies - System Capacity | Road Switcher | Freight | Passenger |
|---|---|---|---|
| Fuel (gals) | 800 | 1200 | 1200 |
| Cooling Water (gals) | 250 | 280 | 330 |
| Water Expansion Tank | 60 | 90 | 90 |
| Lubricating Oil (gals) | 200 | 200 | 230 |
| Governor Oil (gals) Tank-Bayonet Gage | 2½ | 2½ | 2½ |
| Governor Oil (gals) Tank-Sight Glass | 1½ | 1½ | 1½ |
| Air Compressor (gals) | 3 | 3 | 3 |
| Sand Boxes (cu. ft.) | 28 | 22 | 22 |
| Gen. Gear Case (pts) | - | 5 | 5 |
| St. Gen. Water (gals) | 800 | - | 1000 |

## APPROXIMATE WEIGHTS

| | | | |
|---|---|---|---|
| Weight of Locomotive | 230,000 | | |
| "A" Unit | | 230,000 | 303,000 |
| "B" Unit | | 223,000 | 300,000 |
| Four Wheel Truck with Motors | 42,000 | 42,000 | |
| Six Wheel Truck with Motors | - | - | 56,000 |
| Traction Motor with Pinion | 7,240 | 7,240 | 7,240 |
| Traction Motor Pinion | 50 | 50 | 65-97 |
| Traction Motor Blower | 325 | 310 | 310 |
| Axle Gear | 500 | 500 | 500 |

| | Road Switcher | Freight | Passenger |
|---|---|---|---|
| Traction Motor Gear Casing | 230 | 230 | 230 |
| Lubricating Oil Cooler | 900 | 900 | 900 |
| Lubricating Oil Filter | 485 | 485 | 485 |
| Radiator Fan Right Angle Gear Unit | 295 | 295 | 295 |
| Eddy Current Clutch | 530 | 530 | 530 |
| Eddy Current Clutch Drive Shaft | 125 | 600 | 600 |
| Radiator Fan | 240 | 500 | 500 |
| Air Compressor | 1435 | 1435 | 1435 |

## DIESEL ENGINE DATA

Distinction is made between 12 and 16 cylinder engines where necessary. Otherwise figures cover both engines.

| | 12 Cylinder | 16 Cylinder |
|---|---|---|
| Engine H. P. | 1500 | 2000 |
| Rated Engine Speed | 1000 RPM | 1000 RPM |
| Bore and Stroke | 9 x 10½ | 9 x 10½ |
| Number of Cylinders | 12 | 16 |
| Cu. In. Displacement | 8,016 | 10,690 |
| Compression Ratio | 13 to 1 | 13 to 1 |

### FIRING ORDER

| | |
|---|---|
| 12 Cylinder | 1R, 1L, 4R, 4L, 2R, 2L, 6R, 6L, 3R, 3L, 5R, 5L. |
| 16 Cylinder | 1R, 1L, 5R, 5L, 7R, 7L, 3R, 3L, 8R, 8L, 4R, 4L, 2R, 2L, 6R, 6L. |

## TABLE OF CLEARANCES

### CRANKPIN BEARINGS

| Shaft Size | Shell Thickness | Limit of Shell Thickness Wear | Running Clearance |
|---|---|---|---|
| | Standard | | |
| 7.250-7.248 | .3728-.3720 | .003 | .0044-.009 |
| | .010 Undersize | | |
| 7.240-7.238 | .3778-.3770 | .003 | .0044-.009 |
| | .020 Undersize | | |
| 7.230-7.228 | .3828-.3820 | .003 | .0044-.009 |
| | .040 Undersize | | |
| 7.210-7.208 | .3928-.3920 | .003 | .0044-.009 |
| | .060 Undersize | | |
| 7.190-7.188 | .4028-.4020 | .003 | .0044-.009 |
| | .090 Undersize | | |
| 7.160-7.158 | .4178-.4170 | .003 | .0044-.009 |
| | .125 Undersize | | |
| 7.125-7.123 | .4353-.4345 | .003 | .0044-.009 |

### MAIN BEARINGS

| | | | |
|---|---|---|---|
| | Standard | | |
| 8.500-8.498 | .4350-.4342 | .003 | .005 -.010 |
| | .030 Undersize | | |
| 8.470-8.468 | .4500-.4492 | .003 | .005 -.010 |
| | .060 Undersize | | |
| 8.440-8.438 | .4650-.4642 | .003 | .005 -.010 |
| | .090 Undersize | | |
| 8.410-8.408 | .4801-.4792 | .003 | .005 -.010 |
| | .125 Undersize | | |
| 8.375-8.373 | .4976-.4967 | .003 | .005 -.010 |

| Item | New | Limit |
|---|---|---|
| **CAM FOLLOWER ASSEMBLIES** | | |
| Crosshead in Guide (Air-Exhaust-Fuel) | .002 -.004 | .007 |
| Pin in Crosshead (Air-Exhaust-Fuel) | .0025-.0045 | .006 |
| Roller on Pin (Air-Exhaust) | .0025-.0045 | .007 |
| Bushing in Roller (Fuel) | .0025-.0045 | .006 |
| Bushing on Pin (Fuel) | .0025-.0045 | .006 |
| **CAMSHAFT** | | |
| Bearings-Running Clearance | .0025-.005 | Inspect Surface |
| Total Thrust | .012 -.018 | .028 |
| Thrust Ring | .370 -.375 | .340 |
| Idler Gear End Play | .006 -.026 | - |
| **CRANKSHAFT** | | |
| Total Thrust | .015 -.022 | .030 |
| Oil Slinger to Catcher | | |
| Generator End (diametral) | .032 -.038 | - |
| Free End (diametral) | .030 -.040 | - |
| **PISTON** | | |
| Piston to Cylinder Head | .070 -.130 | .060 |
| Piston Skirt to Cylinder Liner | .0235-.0285 | .035 |
| Piston Pin | 3.750 -3.749 | - |
| In Bushing | .0025-.0045 | .006 |
| In Piston | .0005-.0025 | .0035 |
| | (At room temp.) | |
| **PISTON RINGS - STANDARD OR OVERSIZE** | | |
| Compression (gap) | .045 -.055 | .100 |
| Compression (side) | .005 -.007 | .010 |
| Oil Scraper (gap) | .030 -.040 | .060 |
| Oil Scraper (side) | .002 -.0045 | .006 |

| Item | New | Limit |
|---|---|---|
| **GEAR BACKLASH** | | |
| Crankshaft to Idler Gears (Backlash measured with crankshaft lying on bottom of lower shell.) | .0055-.0125 | .016 |
| Idler Gear to Camshaft Gear | .0045-.0105 | .016 |
| Camshaft Gear to Governor Gear | .006 -.009 | .014 |
| Governor Tachometer | | |
| Spiral bevel governor drive gear | .006 -.009 | .014 |
| Drive assembly thrust | .003 -.009 | .014 |
| Gear Train - Free End (Backlash measured with crankshaft lying on bottom of lower shell.) | .006 -.009 | .014 |

Note: Limit clearance satisfactory provided there is no scoring or bad pitting of gear teeth surfaces.

| | | |
|---|---|---|
| **LUBRICATING OIL PUMP** | | |
| Drive shaft bearing clearance | .0055-.007 | .012 |
| Idler gear bearing clearance | .006 -.007 | .012 |
| Pump gear radial clearance | .012 -.015 | .017 |
| Pump gear lateral clearance | .012 -.017 | .027 |
| Drive gear end play | .000 -.031 | - |
| Drive shaft thrust | 1/16 - 1/8 | - |
| Spline drive clearance measured at pitch diameter of drive gear | - | .030 |
| Displacement | | 267 GPM |
| Speed | | 1180 RPM |
| Maximum Operating Pressure | | 90 PSI |
| **WATER PUMP** | | |
| Drive gear end play | .000 -.031 | - |
| Spline drive clearance measured at pitch diameter of drive gear | - | .020 |
| Capacity at 30 PSI | | 650 GPM |
| Speed | | 1710 RPM |
| Discharge Pressure | | 30 PSI |
| Suction Temperature | | 180° F |
| Suction Lift | | 3" HG |

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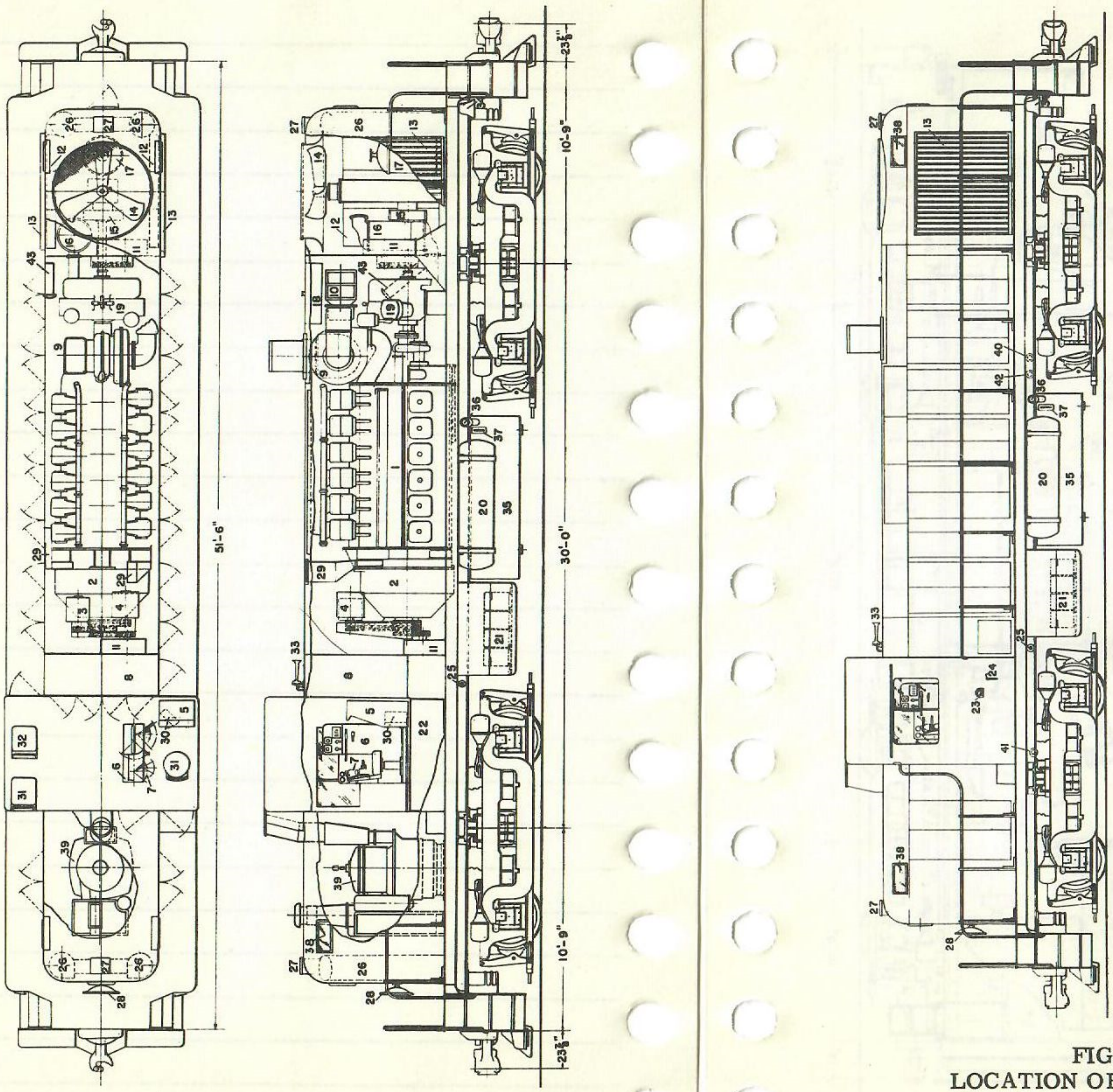
| Item | New | Limit |
|---|---|---|
| **TURNING DEVICE** | | |
| Positioning Pin to Sleeve | .023-.046 | .060 |
| Total End Clearance of Worm to Thrust Bearings | .010-.050 | .125 |
| Worm Shaft to Bushing | .003-.006 | .016 |
| Worm to Worm Gear Backlash | .010-.016 | .030 |
| **VALVE GUIDES** | | |
| Air and Exhaust | .004-.0065 | .009 |
| **VALVE LEVER BUSHINGS** | | |
| Air and Exhaust Valve Lever Shaft | .002-.0035 | .005 |
| **VALVE YOKE ON GUIDE** | | |
| Air and Exhaust | .002-.0035 | .005 |
| **VIBRATION DAMPER (PADDLE TYPE)** | | |
| Clearance Between Outer Ring and Spider | .025-.033 | - |
| Teeth Backlash | 1.000 | - |
| **CYLINDER LINER DIAMETER** * | - | .008 |

* Refer to Page 807.

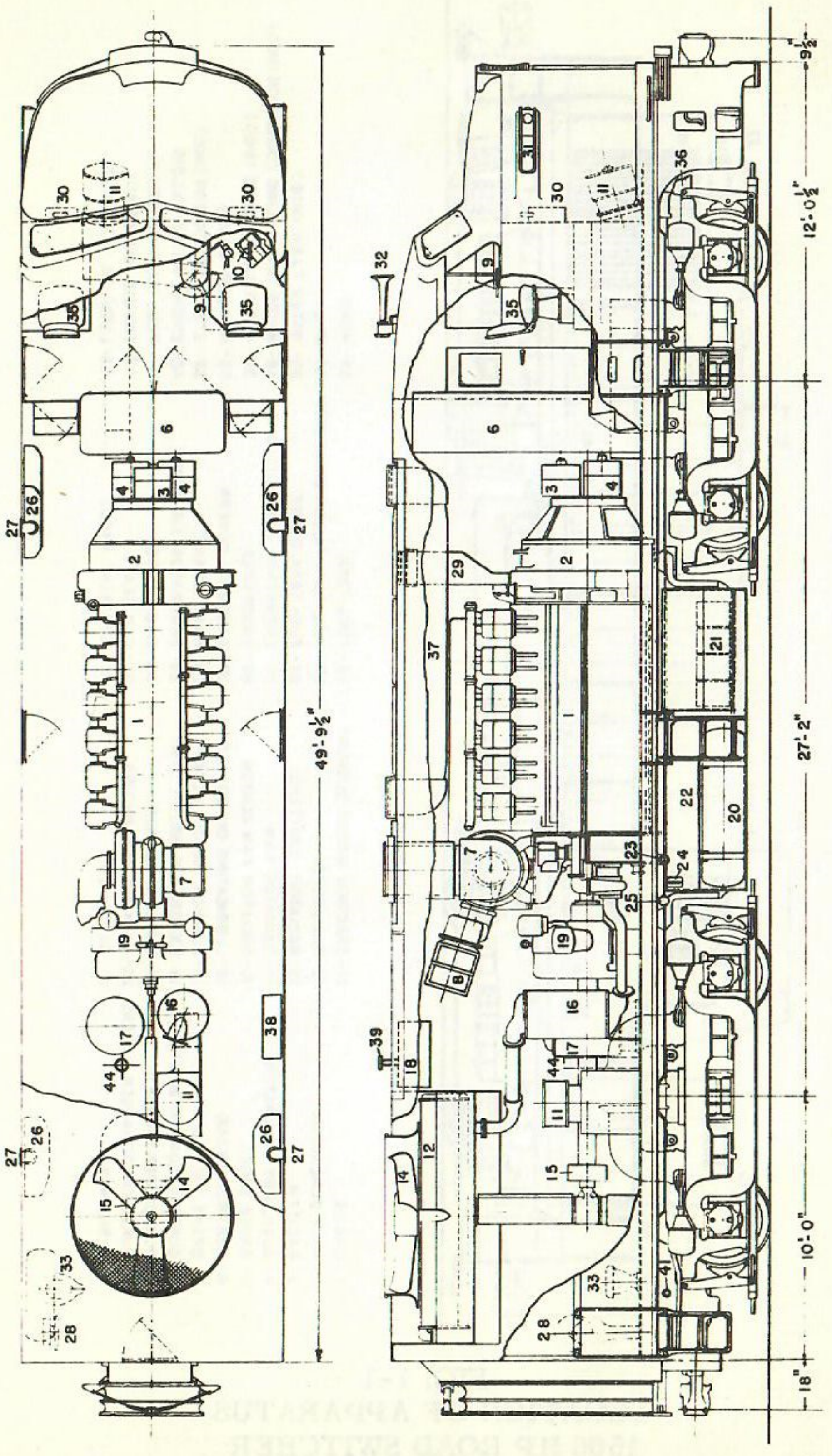
| WEIGHTS (APPROXIMATE) | 12 Cyl. Pounds | 16 Cyl. Pounds |
|---|---|---|
| Diesel Engine (Dry without Generator) | 30,000 | 37,000 |
| Main Generator | 10,450 | 11,500 |
| Auxiliary Generator | 690 | 690 |
| Amplidyne | 535 | 535 |
| Governor | 125 | 125 |
| Tachometer and Overspeed | 35 | 35 |
| Turbosupercharger | 1,750 | 1,750 |
| Turbosupercharger Support | 325 | 325 |
| Main Frame | 6,000 | 8,000 |
| Main Base | 2,550 | 3,400 |
| Generator Adapter | 1,660 | 1,660 |
| Crankshaft | 2,800 | 3,800 |
| Camshaft with Gear | 290 | 360 |
| Camshaft Casing | 290 | 380 |
| Cylinder Head Assembly | 250 | 250 |
| Piston & Connecting Rod Assembly | 130 | 130 |
| Cylinder Liner and Jacket | 175 | 175 |
| Lubricating Oil Pump | 250 | 250 |
| Water Pump | 240 | 240 |
| Booster Pump | 100 | 100 |

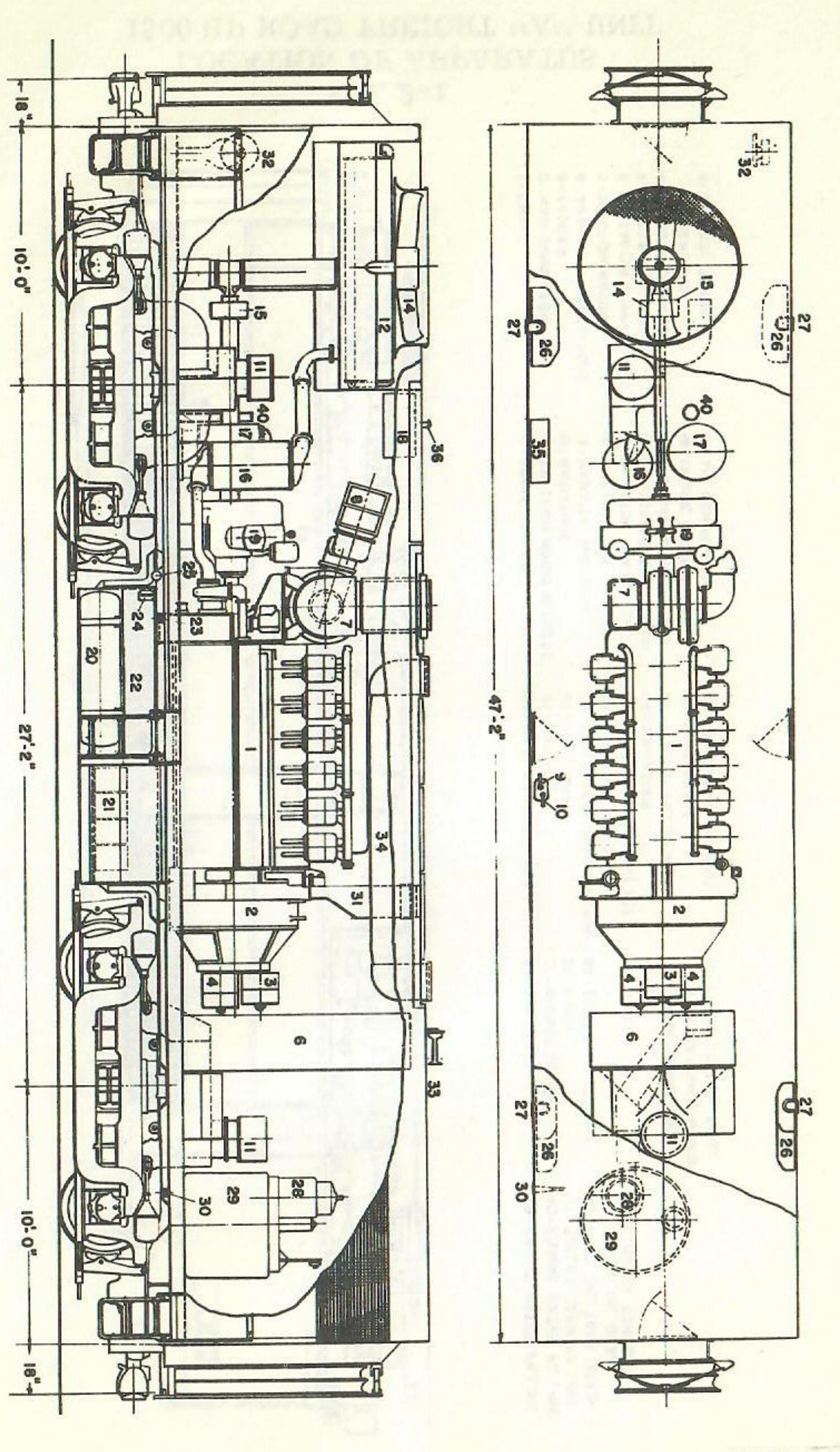
## NOTES

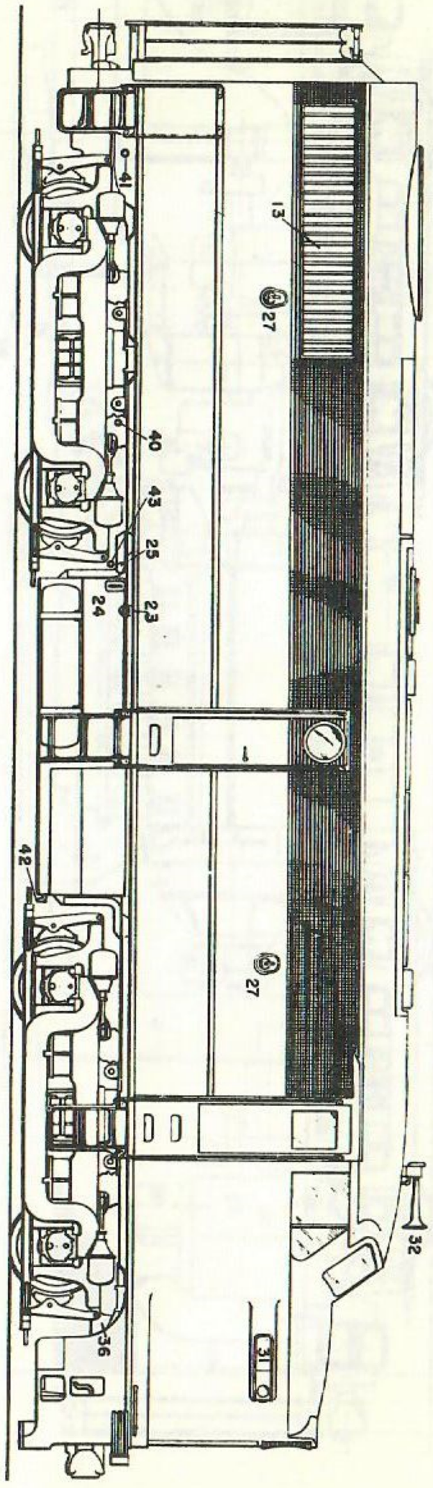


1 - ENGINE
2 - MAIN GENERATOR
3 - EXCITER
4 - AUXILIARY GENERATOR
5 - GAUGE PANEL
6 - CONTROL STAND
7 - BRAKE VALVES
8 - CONTROL COMPARTMENT.
9 - TURBOSUPERCHARGER
10 - TURBOSUPERCHARGER FILTERS & SILENCERS
11 - TRACTION MOTOR BLOWERS
12 - RADIATORS
13 - RADIATOR SHUTTERS
14 - RADIATOR FAN
15 - RADIATOR FAN CLUTCH
16 - LUBRICATING OIL COOLER
17 - LUBRICATING OIL FILTERS
18 - EXPANSION WATER TANK
19 - AIR COMPRESSOR
20 - MAIN AIR RESERVOIRS
21 - BATTERIES
22 - FUEL TANK
23 - FUEL TANK FILLING CONNECTION
24 - FUEL TANK GAUGE
25 - EMERGENCY FUEL CUT OFF
26 - SANDBOXES
27 - SANDBOX COVERS
28 - HAND BRAKE
29 - GENERATOR AIR DUCTS
30 - CAB HEATER
31 - CAB SEATS
32 - CAB SEAT (MOD.)
33 - HORN
34 - BELL
35 - WATER TANK (MOD.)
36 - WATER TANK FILLING CONNECTION (MOD.)
37 - WATER TANK GAUGE (MOD.)
38 - NUMBER BOXES
39 - STEAM GENERATOR (MOD.)
40 - ENGINE WATER FILLING
41 - FUEL OIL TANK DRAIN
42 - ENGINE OIL DRAIN
43 - LUBE OIL STRAINER

FIG. 1-1
LOCATION OF APPARATUS
1500 HP ROAD SWITCHER


49'-9½"
27'-2"
12'-0½"
9½"
10'-0"
18"


18"
10'-0"
27'-2"
10'-0"
18"
47'-2"



1-ENGINE
2-MAIN GENERATOR
3-EXCITER
4-AUXILIARY GENERATORS
5-TRACTION MOTORS
6-CONTACTOR COMPARTMENT
7-TURBOSUPERCHARGER
8-TURBOSUPERCHARGER FILTERS
& SILENCERS
9-CONTROL STAND

10-BRAKE VALVES
11-TRACTION MOTOR BLOWERS
12-RADIATORS
13-RADIATOR SHUTTERS
14-RADIATOR FAN
15-RADIATOR FAN CLUTCH
16-LUBRICATING OIL COOLER
17-LUBRICATING OIL FILTERS
18-ENGINE WATER TANK
19-AIR COMPRESSOR

20-MAIN AIR RESERVOIRS
21-BATTERIES
22-FUEL TANK
23-FUELTANK FILLING CONNECTION
24-FUEL TANK GAUGE
25-EMERGENCY FUEL CUT OFF
26-SANDBOXES
27-SANDBOX FILLING HOLES
28-HAND BRAKE
29-GENERATOR AIR DUCT

30-CAB HEATERS
31-NUMBER BOXES
32-HORN
33-TOILET
35-SEATS
36-BELL
37-DYNAMIC BRAKE GRIDS
& BLOWERS (MODIFICATION)
38-ENGINE CONTROL PANEL

39-ENGINE WATER FILLING
40-ENGINE WATER FILLING
41-TOILET TANK FILLING
42-FUEL OIL TANK DRAIN
43-ENGINE OIL DRAIN
44-LUBE OIL STRAINER

FIG. 2-1
LOCATION OF APPARATUS
1500 HP ROAD FREIGHT "A" UNIT

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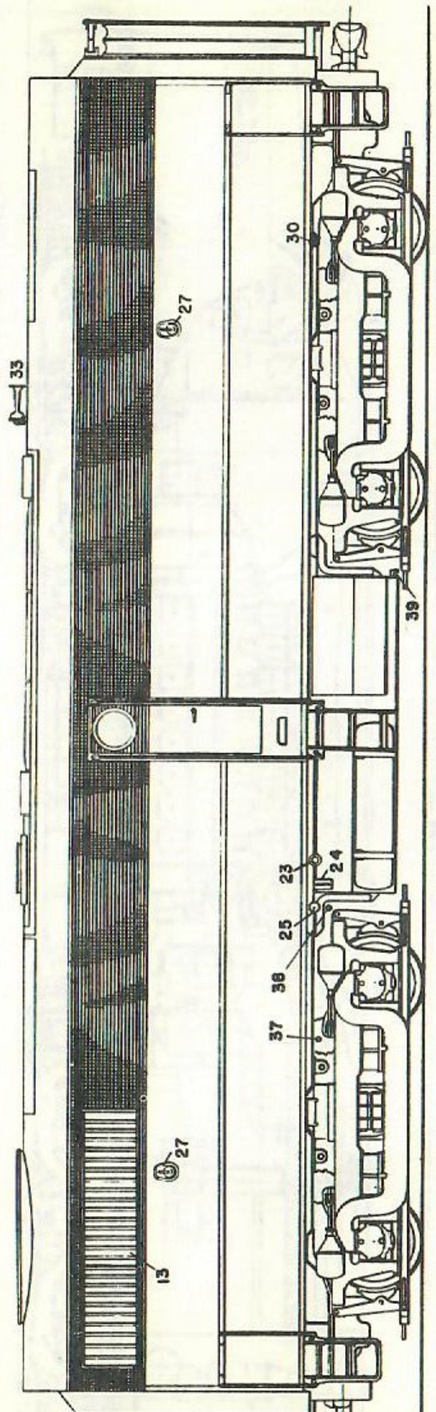


1-ENGINE
2-MAIN GENERATOR
3-EXCITER
4-AUXILIARY GENERATORS
5-TRACTION MOTORS
6-CONTACTOR COMPARTMENT
7-TURBOSUPERCHARGER
8-TURBOSUPERCHARGER FILTERS
& SILENCERS

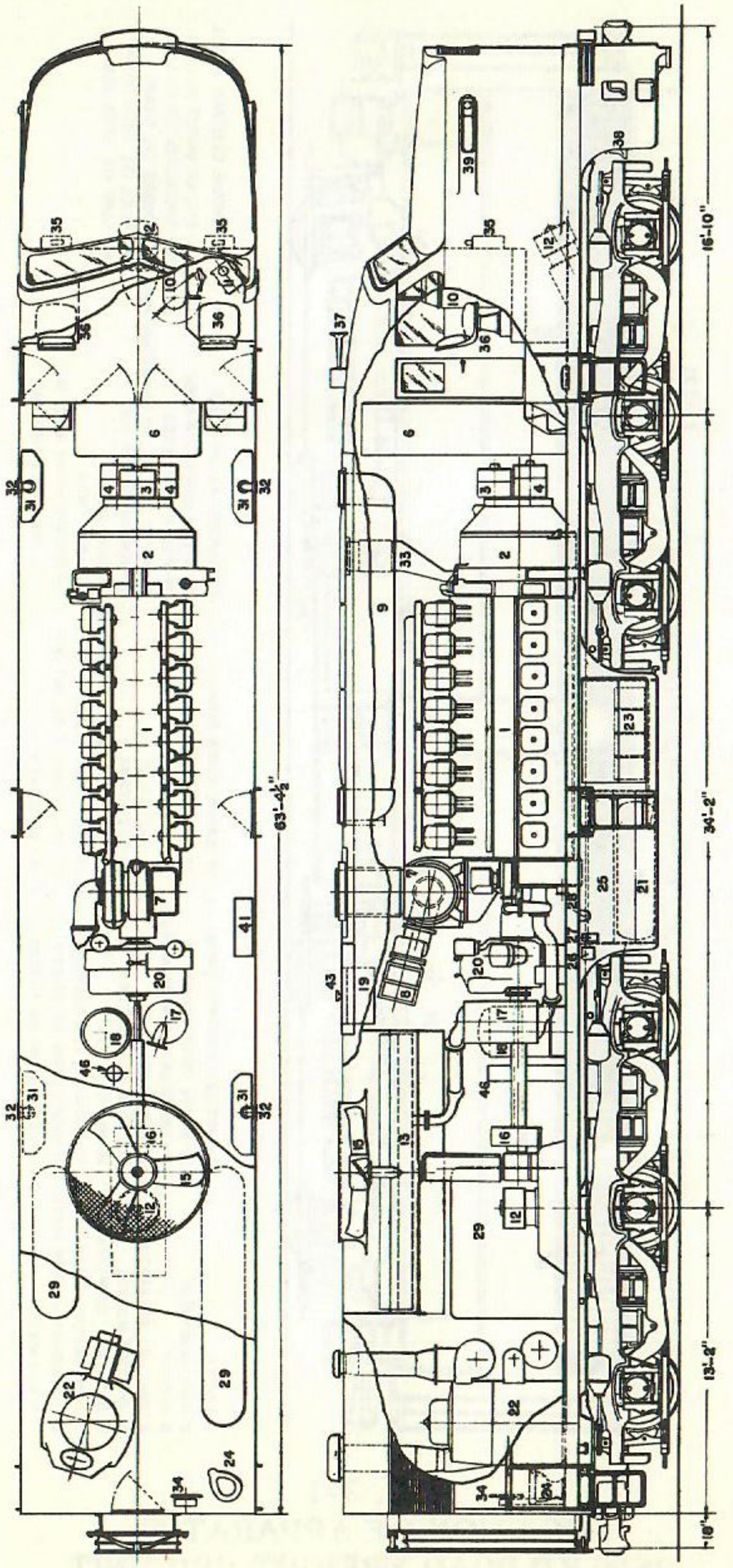
9-HOSTLER CONTROL (MOD.)
10-BRAKE VALVE (MOD.)
11-TRACTION MOTOR BLOWERS
12-RADIATORS
13-RADIATOR SHUTTERS
14-RADIATOR FAN
15-RADIATOR FAN CLUTCH
16-LUBRICATING OIL COOLER
17-LUBRICATING OIL FILTERS

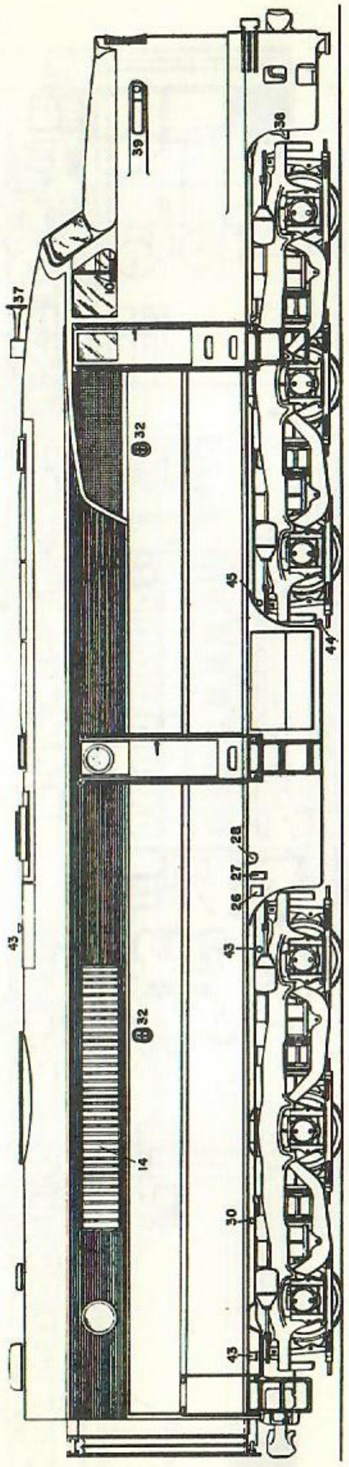
18-ENGINE WATER TANK
19-AIR COMPRESSOR
20-MAIN AIR RESERVOIRS
21-BATTERIES
22-FUEL TANK
23-FUEL TANK FILLING CONNECTION
24-FUEL TANK GAUGE
25-EMERGENCY FUEL CUT OFF
26-SANDBOXES

27-SANDBOX FILLING HOLES
28-STEAM GENERATOR (MOD.)
29-WATER TANK (MOD.)
30-WATER TANK FILLING CONNECTION (MOD.)
31-GENERATOR AIR DUCT
32-HAND BRAKE
33-HORN (MOD.)
34-DYNAMIC BRAKE GRIDS &
BLOWERS (MODIFICATION)

35-ENGINE CONTROL PANEL
36-ENGINE WATER FILLING
37-ENGINE WATER FILLING
38-ENGINE OIL DRAIN
39-FUEL OIL TANK DRAIN
40-LUBE OIL STRAINER

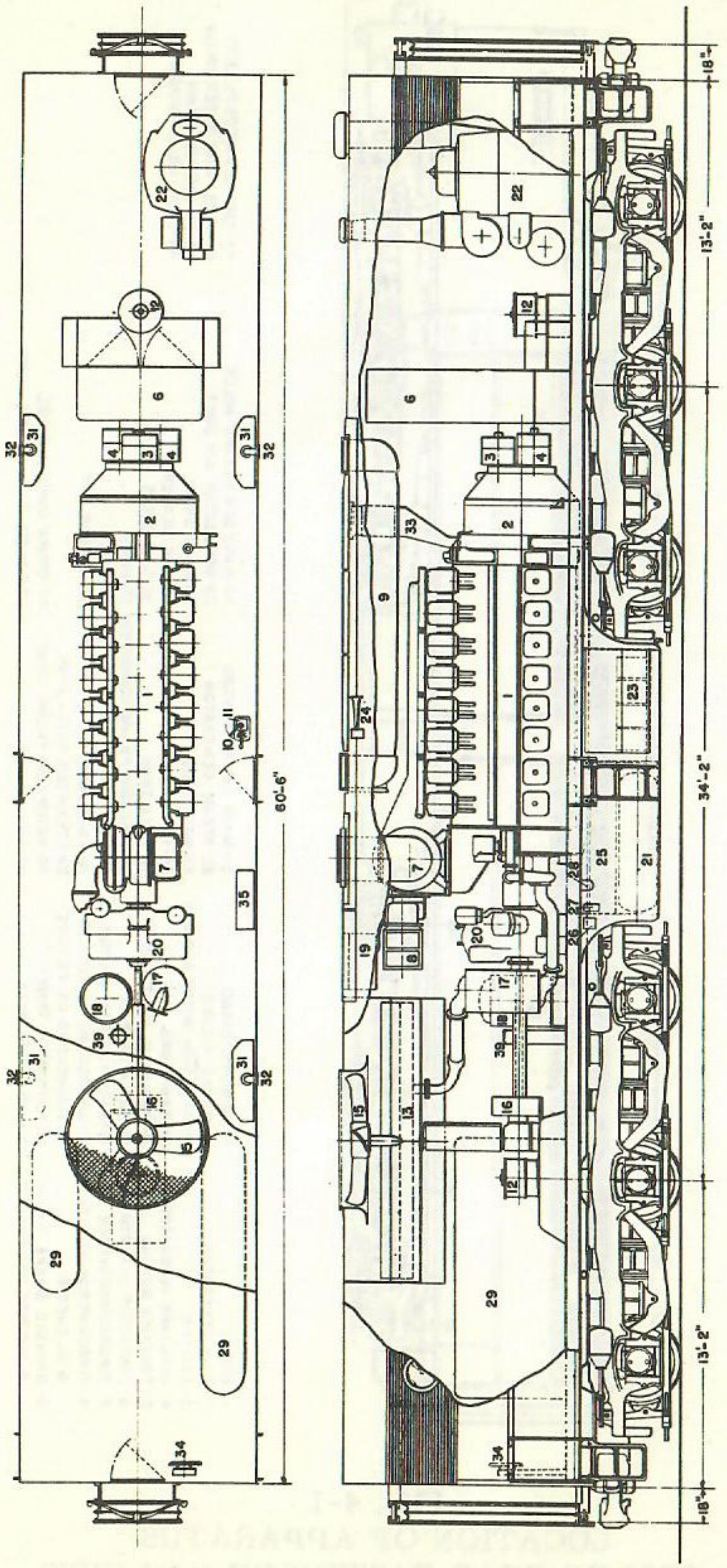
FIG. 3-1
LOCATION OF APPARATUS
1500 HP ROAD FREIGHT "B" UNIT

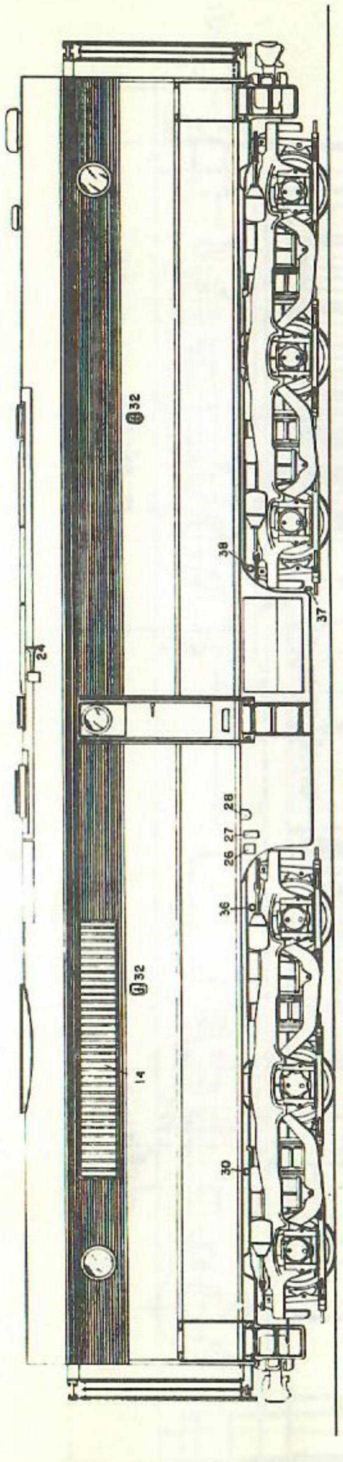




1-ENGINE
2-MAIN GENERATOR
3-EXCITER
4-AUXILIARY GENERATORS
5-TRACTION MOTORS
6-CONTACTOR DEPARTMENT
7-TURBOSUPERCHARGER
8-TURBOSUPERCHARGER FILTERS & SILENCERS
9-DYNAMIC BRAKE GRIDS & BLOWERS. (MODIFICATION)
10-CONTROL STAND
11-BRAKE VALVES
12-TRACTION MOTOR BLOWERS
13-RADIATORS
14-RADIATOR SHUTTERS
15-RADIATOR FAN
16-RADIATOR FAN CLUTCH
17-LUBRICATING OIL COOLER
18-LUBRICATING OIL FILTERS
19-EXPANSION TANK
20-AIR COMPRESSOR
21-MAIN AIR RESERVOIRS
22-STEAM GENERATOR
23-BATTERIES
24-TOILET
25-FUEL TANK
26-FUEL TANK FILLING CONNECTION
27-FUEL TANK GAUGE
28-EMERGENCY FUEL CUT OFF
29-STEAM GEN. WATER TANK.
30-WATER TANK FILLING CONN
31-SAND BOXES
32-SAND BOX FILLING HOLES
33-GENERATOR AIR DUCT
34-HAND BRAKE
35-CAB HEATERS
36-CAB SEATS
37-HORN
38-BELL
39-NUMBER BOX
41-ENGINE CONTROL PANEL
42-TOILET TANK FILLING CONN.
43-ENGINE WATER FILLERS
44-FUEL TANK WATER DRAIN
45-ENGINE OIL DRAIN
46-LUBE. OIL STRAINER

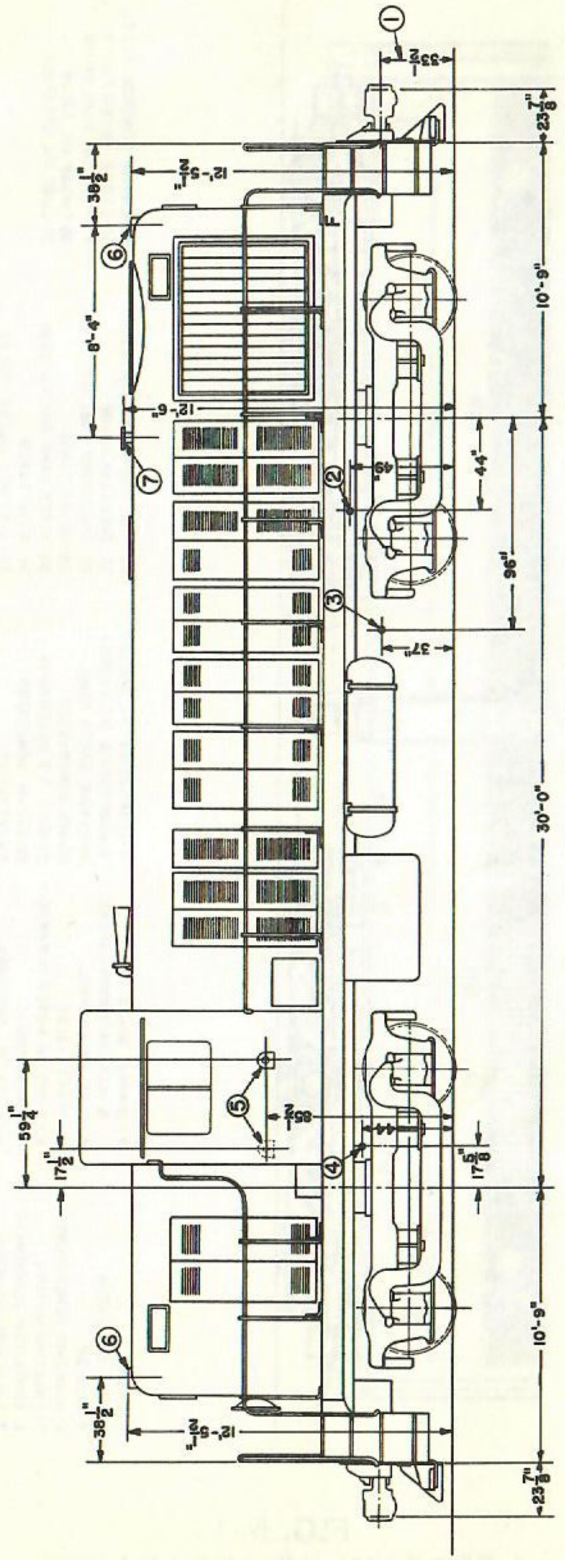
FIG. 4-1
LOCATION OF APPARATUS
2000 HP ROAD PASSENGER "A" UNIT





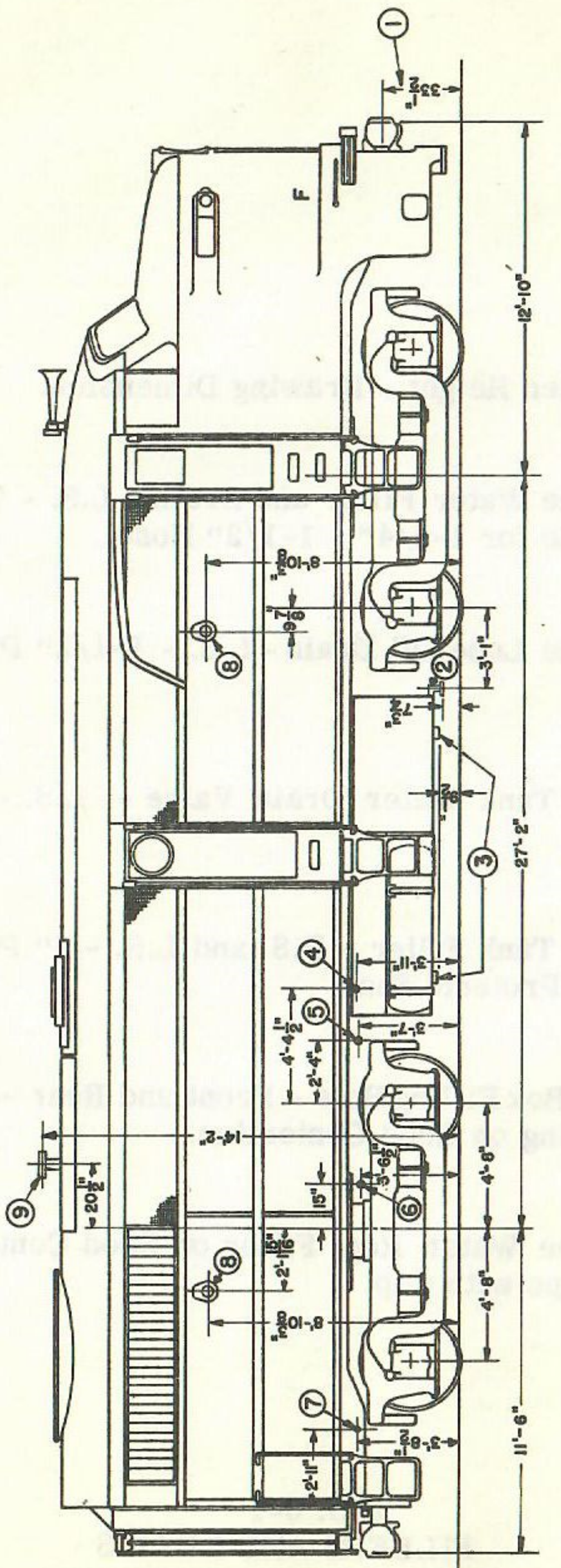
1-ENGINE
2-MAIN GENERATOR
3-EXCITER
4-AUXILIARY GENERATORS
5-TRACTION MOTORS
6-CONTACTOR DEPARTMENT
7-TURBOSUPERCHARGER
8-TURBOSUPERCHARGER FILTERS & SILENCERS
9-DYNAMIC BRAKE GRIDS & BLOWERS. (MODIFICATION)
10-HOSTLER CONTROL
11-BRAKE VALVE
12-TRACTION MOTOR BLOWERS
13-RADIATORS
14-RADIATOR SHUTTERS
15-RADIATOR FAN
16-RADIATOR FAN CLUTCH
17-LUBRICATING OIL COOLER
18-LUBRICATING OIL FILTERS
19-ENGINE WATER TANK
20-AIR COMPRESSOR
21-MAIN AIR RESERVOIRS
22-STEAM GENERATOR
23-BATTERIES
24-HORN
25-FUEL TANK
26-FUEL TANK FILLING CONNECTION
27-FUEL TANK GAUGE
28-EMERGENCY FUEL CUT OFF
29-WATER TANKS
30-WATER TANK FILLING CONN
31-SAND BOXES
32-SAND BOX FILLING HOLES
33-GENERATOR AIR DUCT
34-HAND BRAKE
35-ENGINE CONTROL PANEL
36-ENGINE WATER FILLING
37-FUEL OIL TANK DRAIN
38-ENGINE OIL DRAIN
39-LUBE OIL STRAINER

FIG. 5-1
LOCATION OF APPARATUS
2000 HP ROAD PASSENGER "B" UNIT



1. Coupler Height - Drawing Dimension.
2. Engine Water Filler and Drain - L.S. - Tapered Nozzle for 1-1/4" - 1-1/2" Hose.
3. Engine Lube Oil Drain - L.S. - 1-1/2" Pipe with Cap.
4. Fuel Tank Water Drain Valve - L.S. - 1-1/2" Pipe.
5. Fuel Tank Filler - R.S. and L.S. - 4" Pipe with #384 Protecto Seal.
6. Sand Box Filling Hole - Front and Rear - 8" x 8" Opening on Hood Centerline.
7. Engine Water Roof Filler on Hood Centerline - 2" Pipe with Cap.

FIG. 6-1
FILLERS AND DRAINS
1500 HP ROAD SWITCHER



1. Coupler Height - Drawing Dimension.

2. Fuel Tank Water Drain Valve on Tank Centerline 1-1/2" Pipe with Cap.

3. Fuel Tank Drain Plugs - 4" Pipe - 4" Off Tank Centerline.

4. Fuel Tank Filler - R.S. and L.S. - 4" Pipe with #384 Protecto Seal.

5. Engine Lube Oil Drain - R.S. - 2" Pipe with Cap.

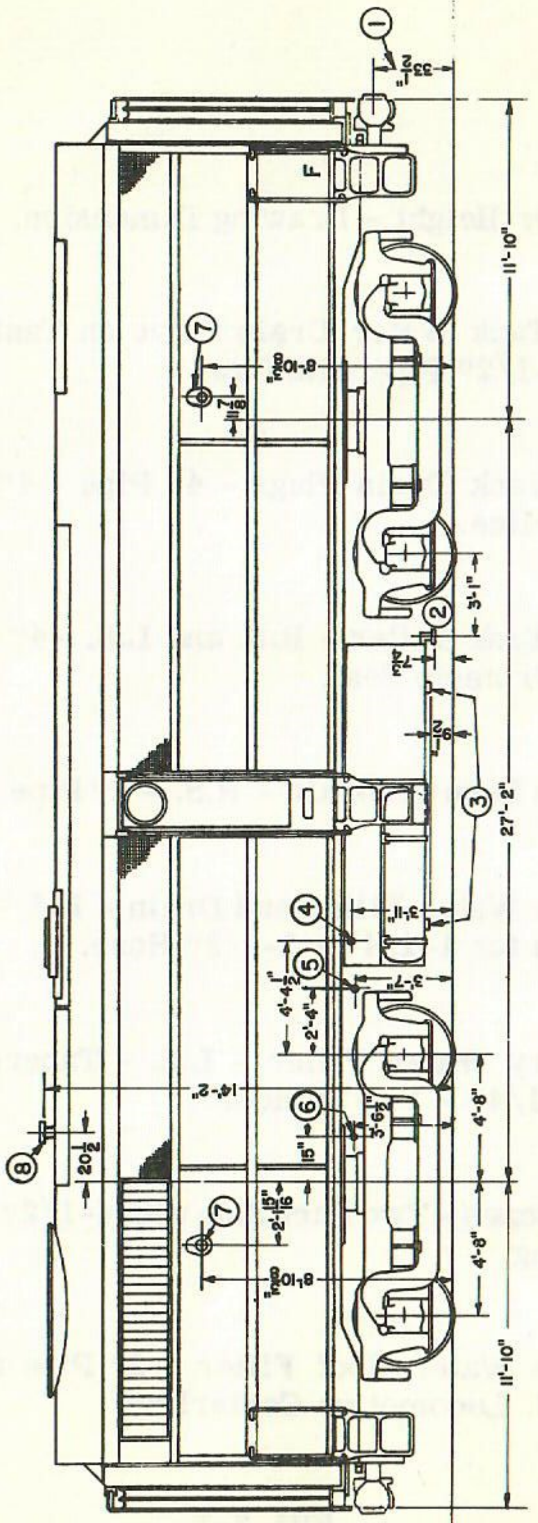
6. Engine Water Filler and Drain - R.S. - Tapered Nozzle for 1-1/4" - 1-1/2" Hose.

7. Sanitary Water Filler - L.S. - Tapered Nozzle for 1-1/4" - 1-1/2" Hose.

8. Sand Boxes - Two Each Side with 4-1/2" Diameter Opening.

9. Engine Water Roof Filler - 2" Pipe with Cap - 2" L.S. Locomotive Centerline.

FIG. 7-1
FILLERS AND DRAINS
1500 HP ROAD FREIGHT "A" UNIT


1
33"
F
11'-10"
7
10'-8"
2
3'-1"
3
27'-2"
4
5
4'-4"
2'-4"
14'-5"
6
3'-6"
4'-8"
15"
8
20 1/2
7
2'-1 5/16"
10'-8"
4'-8"
11'-10"

1. Coupler Height - Drawing Dimension.

2. Fuel Tank Water Drain Valve on Tank Centerline. 1-1/2" Pipe with Cap.

3. Fuel Tank Drain Plugs - 4" Pipe - 4" Off Tank Centerline.

4. Fuel Tank Filler - R.S. and L.S. - 4" Pipe with #384 Protecto Seal.

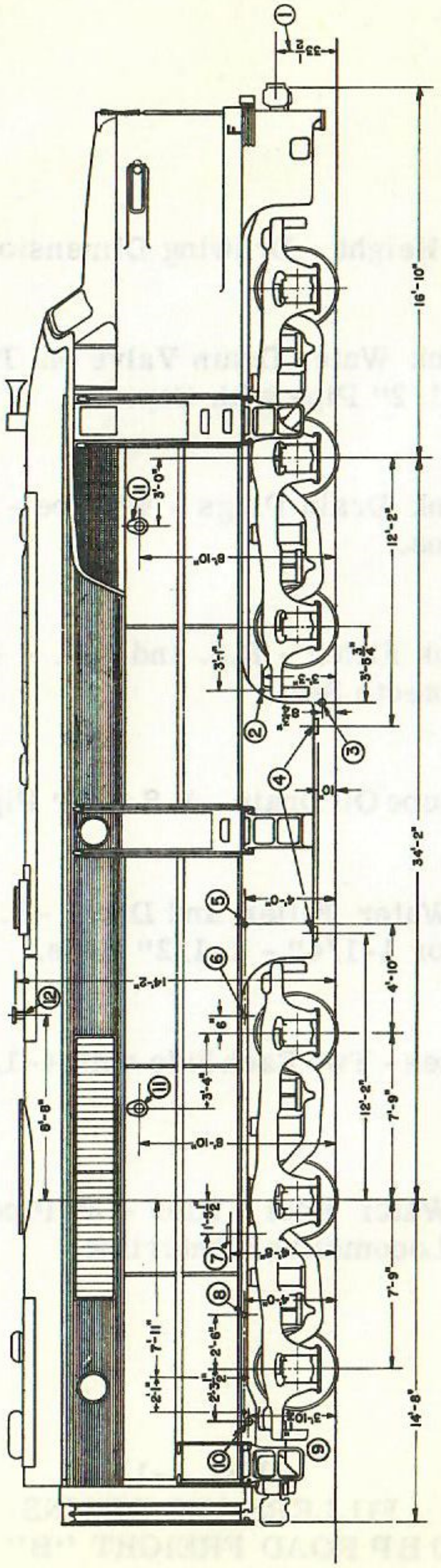
5. Engine Lube Oil Drain - R.S. - 2" Pipe with Cap.

6. Engine Water Filler and Drain -R.S.- Tapered Nozzle for 1-1/4" - 1-1/2" Hose.

7. Sand Boxes - Two Each Side with 4-1/2" diameter opening.

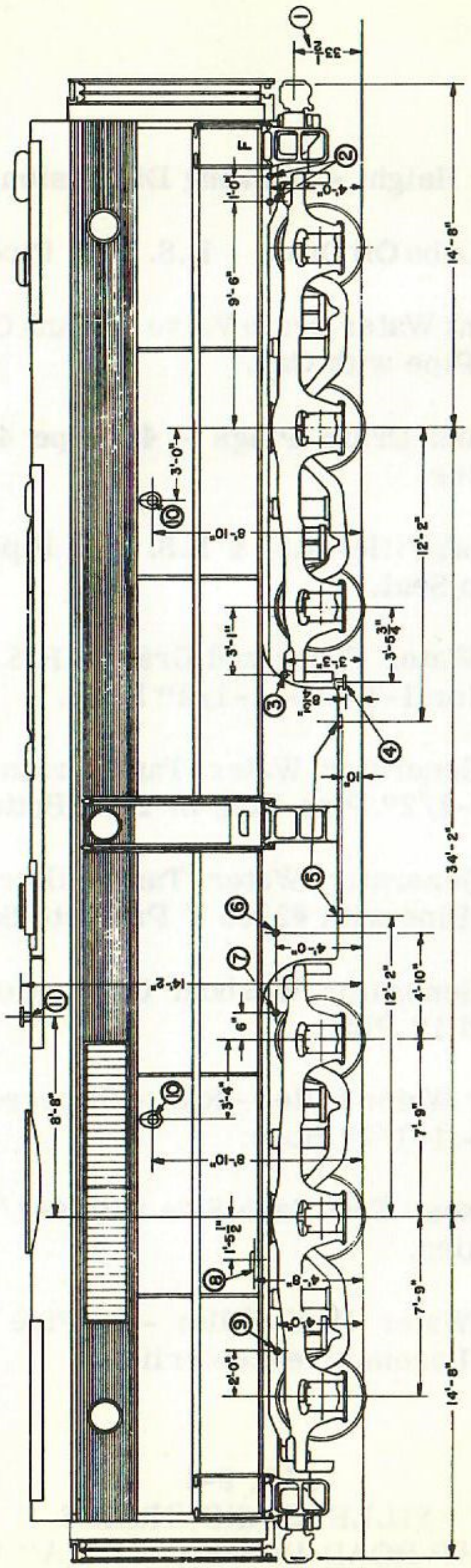
8. Engine Water Roof Filler - 2" Pipe with Cap - 2" L.S. Locomotive Centerline.

FIG. 8-1
FILLERS AND DRAINS
1500 HP ROAD FREIGHT "B" UNIT



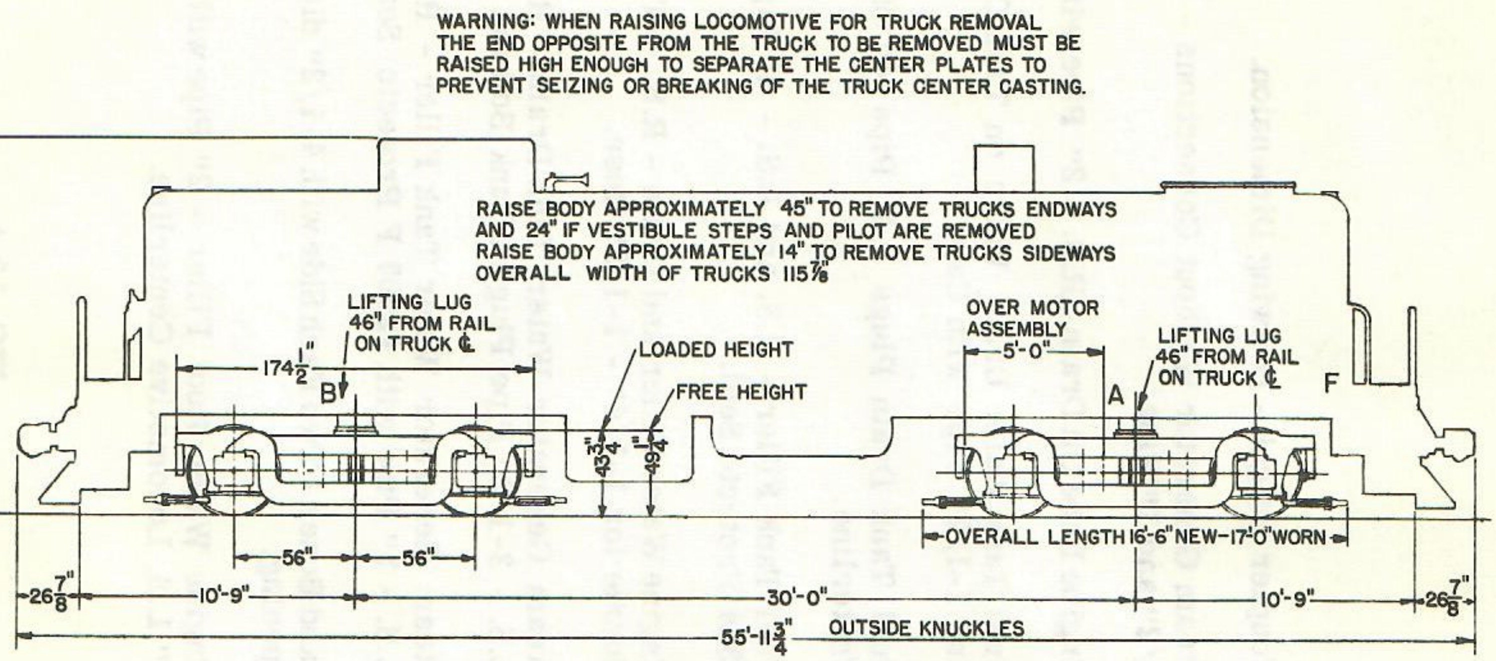
1. Coupler Height - Drawing Dimension.
2. Engine Lube Oil Drain - R.S. - 2" Pipe with Cap.
3. Fuel Tank Water Drain Valve on Tank Centerline - 1-1/2" Pipe with Cap.
4. Fuel Tank Drain Plugs - 4" Pipe 4" Off Tank Centerline.
5. Fuel Tank Filler R.S. & L.S. - 4" Pipe with #384 Protecto Seal.
6. Engine Water Filler and Drain - R.S. - Tapered Nozzle for 1-1/4" - 1-1/2" Hose.
7. Steam Generator Water Tank Drain - R.S. and L.S. - 2-1/2" Pipe Plug in Tank Bottom.
8. Steam Generator Water Tank Filler - R.S. and L.S. 3" Pipe with #2903 F Protecto Seal Cap.
9. Steam Generator Washout Connections - L.S. - 1/2" and 1" Pipe.
10. Sanitary Water Filler - R.S. - Tapered nozzle for 1-1/4" - 1-1/2" Hose.
11. Sand Boxes - Two Each Side with 4-1/2" diameter opening.
12. Engine Water Roof Filler - 2" Pipe with Cap - 2" L S. Locomotive Centerline.

FIG. 9-1
FILLERS AND DRAINS
2000 HP ROAD PASSENGER "A" UNIT



1. Coupler Height - Drawing Dimension.
2. Steam Generator Washout Connections - R.S. - 1/2" and 1" Pipe.
3. Engine Lube Oil Drain - R.S. - 2" Pipe with Cap.
4. Fuel Tank Water Drain Valve on Tank Centerline 1-1/2" Pipe with Cap.
5. Fuel Tank Drain Plugs - 4" Pipe 4" Off Tank Centerline.
6. Fuel Tank Filler - R.S. and L.S. - 4" Pipe with #384 Protecto Seal.
7. Engine Water Filler and Drain - R.S. - Tapered Nozzle for 1-1/4" - 1-1/2" Hose.
8. Steam Generator Water Tank Drain - R.S. and L.S. - 2-1/2" Pipe Plug in Tank Bottom.
9. Steam Generator Water Tank Filler - R.S. and L.S. - 3" Pipe with #2903 F Protecto Seal Cap.
10. Sand Boxes - Two Each Side with 4-1/2" diameter opening.
11. Engine Water Roof Filler - 2" Pipe with Cap - 2" L.S. Locomotive Centerline.

FIG. 10-1
FILLERS AND DRAINS
2000 HP ROAD PASSENGER "B" UNIT



WARNING: WHEN RAISING LOCOMOTIVE FOR TRUCK REMOVAL THE END OPPOSITE FROM THE TRUCK TO BE REMOVED MUST BE RAISED HIGH ENOUGH TO SEPARATE THE CENTER PLATES TO PREVENT SEIZING OR BREAKING OF THE TRUCK CENTER CASTING.

RAISE BODY APPROXIMATELY 45" TO REMOVE TRUCKS ENDWAYS AND 24" IF VESTIBULE STEPS AND PILOT ARE REMOVED
RAISE BODY APPROXIMATELY 14" TO REMOVE TRUCKS SIDEWAYS
OVERALL WIDTH OF TRUCKS 115⅞

LIFTING LUG 46" FROM RAIL ON TRUCK ℄
174½"
B
LOADED HEIGHT
FREE HEIGHT
43¾"
49¼"
OVER MOTOR ASSEMBLY
5'-0"
LIFTING LUG 46" FROM RAIL ON TRUCK ℄
A
F
14'-5"
56"
56"
OVERALL LENGTH 16'-6" NEW-17'-0" WORN
26⅞"
10'-9"
30'-0"
10'-9"
26⅞"
55'-11¾"
OUTSIDE KNUCKLES

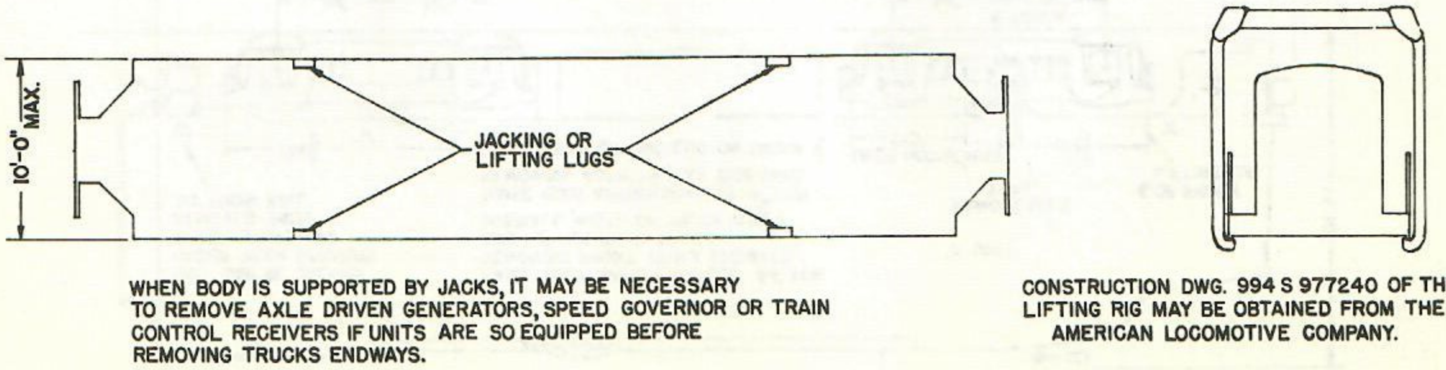
① JACKING AND LIFTING DATA WITH TRUCKS ATTACHED SEE TABLE BELOW-LINES 1 THRU 3

② JACKING AND LIFTING DATA WITHOUT TRUCKS SEE TABLE BELOW-LINE 4

| LINE | JACK OR LIFT AT | FULCRUM | LOAD "A" | LOAD "B" | RAIL LOAD FT. TRUCK | RAIL LOAD BK. TRUCK |
|---|---|---|---|---|---|---|
| 1 | A | B | 125,400 | — | — | 122,300 |
| 2 | B | A | — | 122,300 | 125,400 | — |
| 3 | A & B | — | 125,400 | 122,300 | — | — |
| 4 | A & B | — | 83,600 | 80,500 | — | — |

LOADED WEIGHTS

WEIGHT OF ONE MOTOR TRUCK COMPLETE 42,000 LBS.



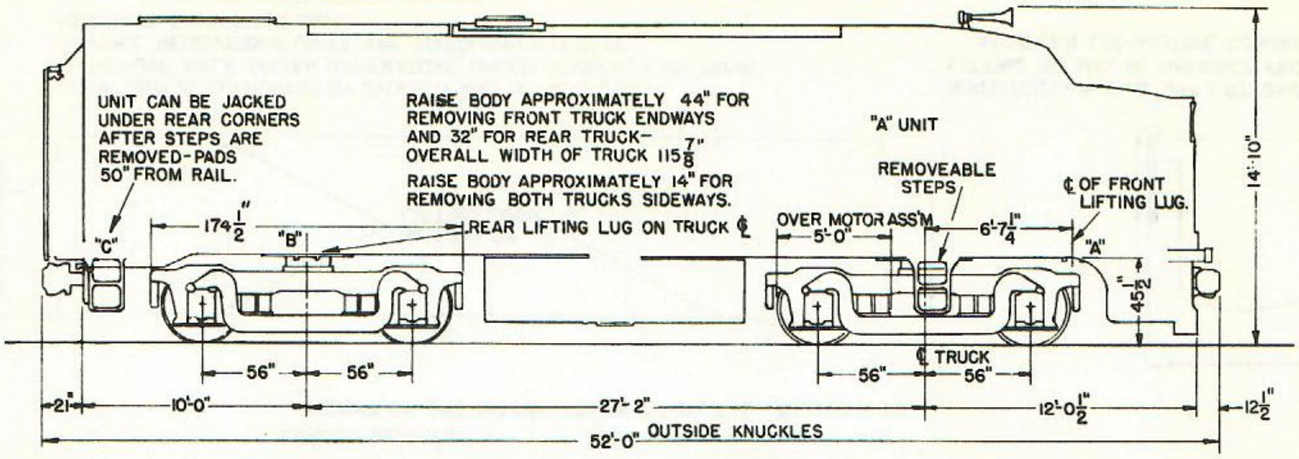
10'-0" MAX.
JACKING OR LIFTING LUGS

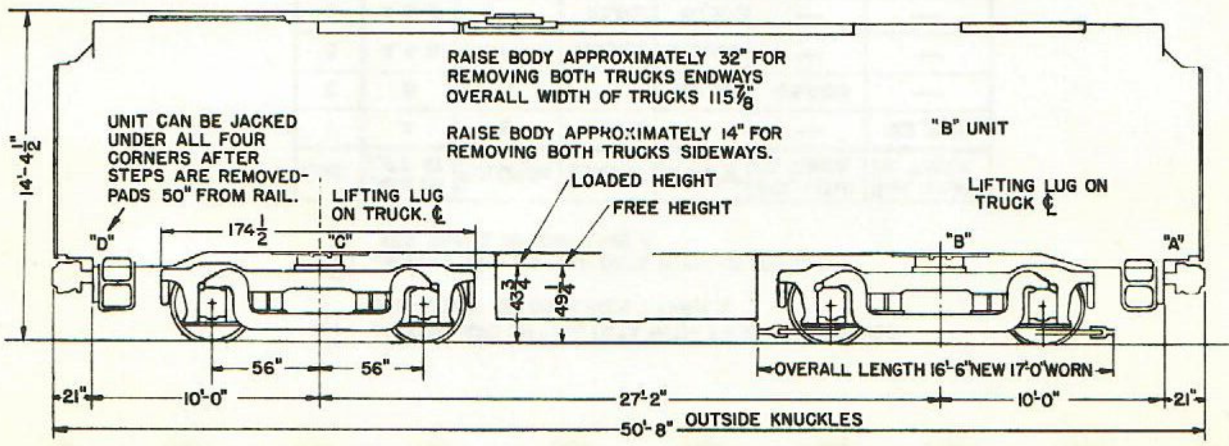
WHEN BODY IS SUPPORTED BY JACKS, IT MAY BE NECESSARY TO REMOVE AXLE DRIVEN GENERATORS, SPEED GOVERNOR OR TRAIN CONTROL RECEIVERS IF UNITS ARE SO EQUIPPED BEFORE REMOVING TRUCKS ENDWAYS.

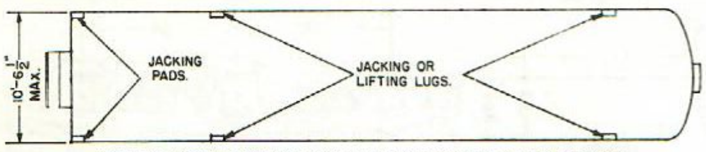
CONSTRUCTION DWG. 994 S 977240 OF THE LIFTING RIG MAY BE OBTAINED FROM THE AMERICAN LOCOMOTIVE COMPANY.

FIG. 11-1
JACKING AND LIFTING DIAGRAM
1500 HP ROAD SWITCHER

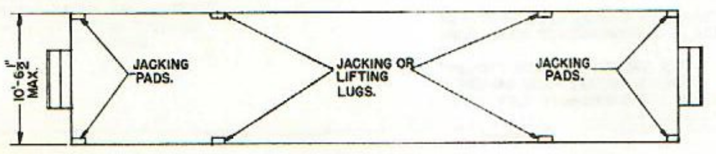
WARNING:- WHEN RAISING LOCOMOTIVE BODY FOR TRUCK REMOVAL, THE END OPPOSITE FROM THE TRUCK TO BE REMOVED MUST BE RAISED HIGH ENOUGH TO SEPARATE THE CENTER PLATES TO PREVENT SEIZING OR BREAKING OF THE TRUCK CENTER CASTING.


UNIT CAN BE JACKED UNDER REAR CORNERS AFTER STEPS ARE REMOVED-PADS 50" FROM RAIL.
RAISE BODY APPROXIMATELY 44" FOR REMOVING FRONT TRUCK ENDWAYS AND 32" FOR REAR TRUCK-
OVERALL WIDTH OF TRUCK 115 7/8"
RAISE BODY APPROXIMATELY 14" FOR REMOVING BOTH TRUCKS SIDEWAYS.
"A" UNIT
REMOVEABLE STEPS
℄ OF FRONT LIFTING LUG.
"C"
174 1/2"
"B"
REAR LIFTING LUG ON TRUCK ℄
OVER MOTOR ASS'M
5'-0"
6'-7 1/4"
"A"
45 1/2"
14'-10"
℄ TRUCK
56"
56"
56"
56"
21"
10'-0"
27'-2"
12'-0 1/2"
12 1/2"
52'-0" OUTSIDE KNUCKLES


RAISE BODY APPROXIMATELY 32" FOR REMOVING BOTH TRUCKS ENDWAYS
OVERALL WIDTH OF TRUCKS 115 7/8"
RAISE BODY APPROXIMATELY 14" FOR REMOVING BOTH TRUCKS SIDEWAYS.
"B" UNIT
UNIT CAN BE JACKED UNDER ALL FOUR CORNERS AFTER STEPS ARE REMOVED-PADS 50" FROM RAIL.
LIFTING LUG ON TRUCK ℄
LOADED HEIGHT
FREE HEIGHT
LIFTING LUG ON TRUCK ℄
14'-4 1/2"
"D"
174 1/2"
"C"
"B"
"A"
43 3/4
49 1/4
56"
56"
OVERALL LENGTH 16'-6" NEW 17'-0" WORN
21"
10'-0"
27'-2"
10'-0"
21"
50'-8" OUTSIDE KNUCKLES


10'-6 1/2" MAX.
JACKING PADS.
JACKING OR LIFTING LUGS.

WHEN BODY IS SUPPORTED BY JACKS IT MAY BE NECESSARY TO REMOVE AXLE DRIVEN GENERATORS, SPEED GOVERNOR OR TRAIN CONTROL RECEIVERS, IF UNITS ARE SO EQUIPPED, BEFORE REMOVING TRUCKS ENDWAYS


10'-6 1/2" MAX.
JACKING PADS.
JACKING OR LIFTING LUGS.
JACKING PADS.

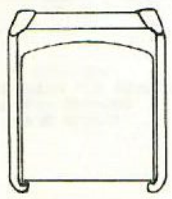
① JACKING AND LIFTING DATA WITH TRUCKS ATTACHED-SEE TABLE BELOW-LINES 1 THRU 5

② JACKING AND LIFTING DATA WITHOUT TRUCKS-SEE TABLE BELOW-LINES 6 & 7

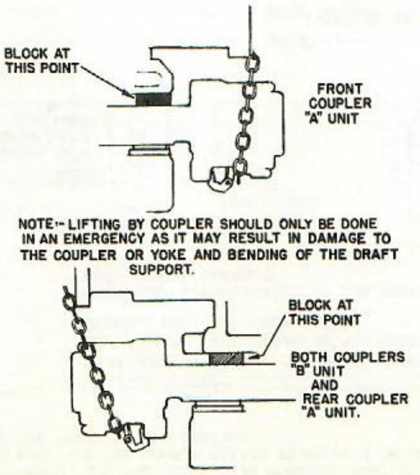
| LINE | JACK OR LIFT AT | FULCRUM | LOAD "A" | LOAD "B" | LOAD "C" | RAIL LOAD FT. TRUCK | RAIL LOAD BK. TRUCK |
|---|---|---|---|---|---|---|---|
| 1 | A | B | 96,900# | —— | —— | —— | 138,400# |
| 2 | B | FT. TRK. | —— | 114,875# | —— | 120,425# | —— |
| 3 | C | FT. TRK. | —— | —— | 84,700# | 150,600# | —— |
| 4 | A & B | —— | 96,900# | 138,400# | —— | —— | —— |
| 5 | A & C | —— | 127,700# | —— | 107,600# | —— | —— |
| 6 | A & B | —— | 63,200# | 83,500# | —— | —— | —— |
| 7 | A & C | —— | 82,950# | —— | 68,750# | —— | —— |

LOADED WEIGHTS

WEIGHT OF ONE MOTOR TRUCK COMPLETE 42,000 LBS.



CONSTRUCTION DWG. 994 S 977240 OF THE LIFTING RIG MAY BE OBTAINED FROM THE AMERICAN LOCOMOTIVE COMPANY.


BLOCK AT THIS POINT
FRONT COUPLER "A" UNIT
BLOCK AT THIS POINT
BOTH COUPLERS "B" UNIT AND REAR COUPLER "A" UNIT.

NOTE:- LIFTING BY COUPLER SHOULD ONLY BE DONE IN AN EMERGENCY AS IT MAY RESULT IN DAMAGE TO THE COUPLER OR YOKE AND BENDING OF THE DRAFT SUPPORT.

① JACKING AND LIFTING DATA WITH TRUCKS ATTACHED-SEE TABLE BELOW-LINES 1 THRU 8

② JACKING AND LIFTING DATA WITHOUT TRUCKS-SEE TABLE BELOW—LINES 9 THRU 12

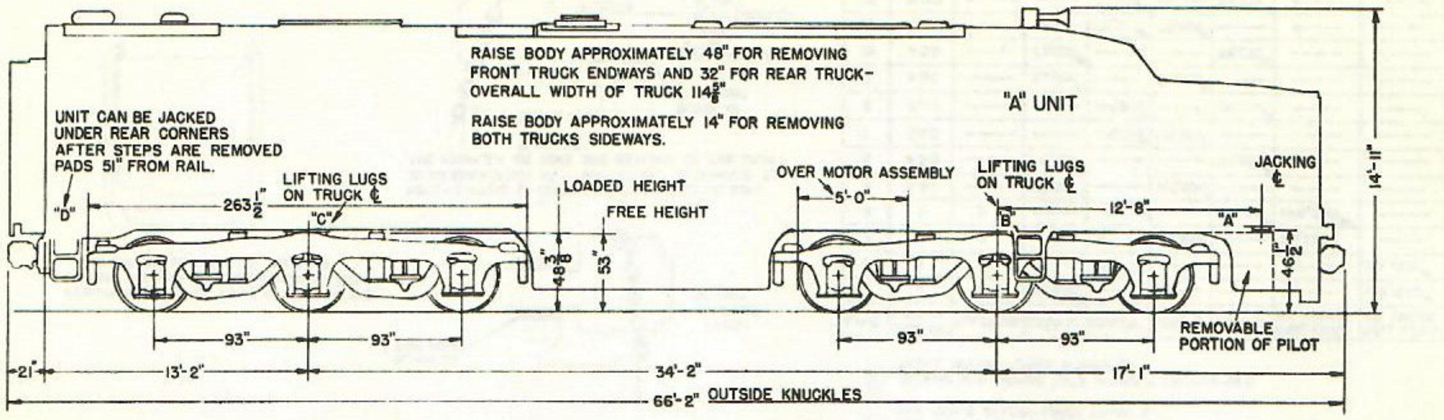
| LINE | JACK OR LIFT AT | FULCRUM | LOAD "A" | LOAD "B" | LOAD "C" | LOAD "D" | RAIL LOAD FT. TRUCK | RAIL LOAD BK. TRUCK |
|---|---|---|---|---|---|---|---|---|
| 1 | A | C | 84,600# | —— | —— | —— | —— | 145,800# |
| 2 | B | C | —— | 114,750# | —— | —— | —— | 115,650# |
| 3 | C | B | —— | —— | 116,650# | —— | 114,750# | —— |
| 4 | D | B | —— | —— | —— | 86,200# | 144,200# | —— |
| 5 | A & C | —— | 84,600# | —— | 145,800# | —— | —— | —— |
| 6 | A & D | —— | 114,750# | —— | —— | 115,650# | —— | —— |
| 7 | B & C | —— | —— | 114,750# | 115,650# | —— | —— | —— |
| 8 | B & D | —— | —— | 144,200# | —— | 86,200# | —— | —— |
| 9 | A & C | —— | 53,800# | —— | 93,000# | —— | —— | —— |
| 10 | A & D | —— | 73,130# | —— | —— | 73,670# | —— | —— |
| 11 | B & C | —— | —— | 72,950# | 73,850# | —— | —— | —— |
| 12 | B & D | —— | —— | 92,330# | —— | 54,470# | —— | —— |

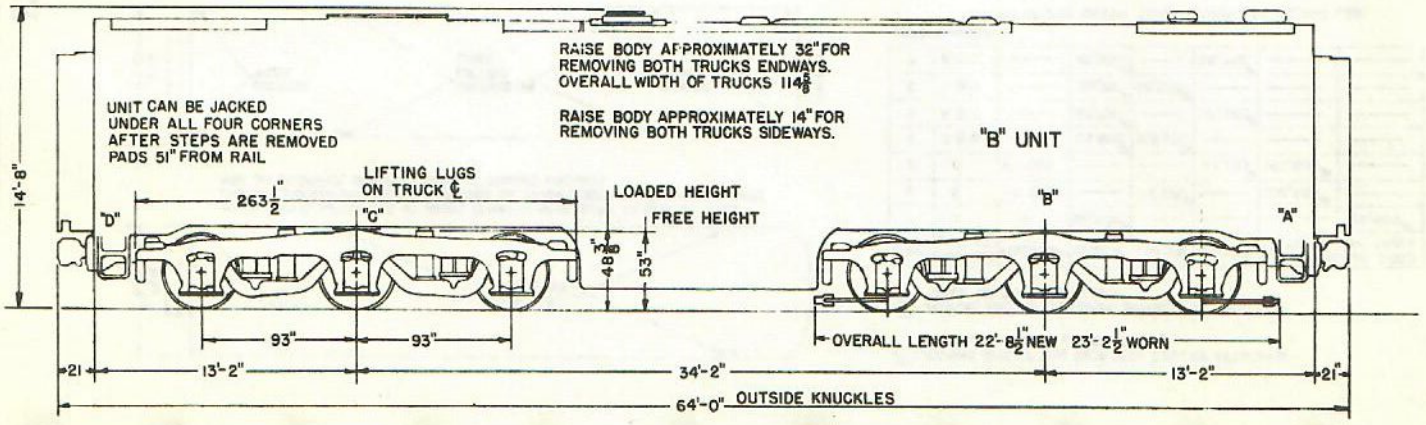
LOADED WEIGHTS

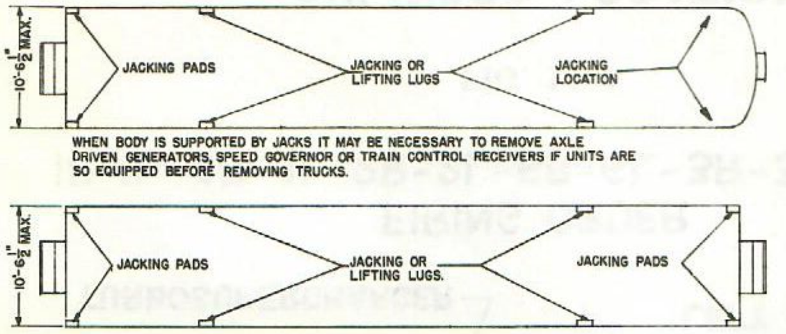
WEIGHT OF ONE MOTOR TRUCK COMPLETE 42,000 LBS.

FIG. 12-1
JACKING AND LIFTING DIAGRAM
1500 HP ROAD FREIGHT "A" AND "B" UNITS

WARNING:- WHEN RAISING LOCOMOTIVE BODY FOR TRUCK REMOVAL, THE END OPPOSITE FROM THE TRUCK TO BE REMOVED MUST BE RAISED HIGH ENOUGH TO SEPARATE THE CENTER PLATES TO PREVENT SEIZING OR BREAKING OF THE TRUCK CENTER CASTING.


RAISE BODY APPROXIMATELY 48" FOR REMOVING FRONT TRUCK ENDWAYS AND 32" FOR REAR TRUCK- OVERALL WIDTH OF TRUCK 114$\frac{5}{8}$"
RAISE BODY APPROXIMATELY 14" FOR REMOVING BOTH TRUCKS SIDEWAYS.
"A" UNIT
UNIT CAN BE JACKED UNDER REAR CORNERS AFTER STEPS ARE REMOVED PADS 51" FROM RAIL.
"D"
263$\frac{1}{2}$"
LIFTING LUGS ON TRUCK ℄
"C"
LOADED HEIGHT
FREE HEIGHT
48$\frac{3}{8}$"
53"
OVER MOTOR ASSEMBLY
5'-0"
LIFTING LUGS ON TRUCK ℄
"B"
12'-8"
"A"
JACKING ℄
46$\frac{1}{2}$"
14'-11"
REMOVABLE PORTION OF PILOT
93"
93"
93"
93"
21"
13'-2"
34'-2"
17'-1"
66'-2" OUTSIDE KNUCKLES


RAISE BODY APPROXIMATELY 32" FOR REMOVING BOTH TRUCKS ENDWAYS. OVERALL WIDTH OF TRUCKS 114$\frac{5}{8}$
RAISE BODY APPROXIMATELY 14" FOR REMOVING BOTH TRUCKS SIDEWAYS.
"B" UNIT
UNIT CAN BE JACKED UNDER ALL FOUR CORNERS AFTER STEPS ARE REMOVED PADS 51" FROM RAIL
14'-8"
"D"
263$\frac{1}{2}$"
LIFTING LUGS ON TRUCK ℄
"C"
LOADED HEIGHT
FREE HEIGHT
48$\frac{3}{8}$"
53"
"B"
"A"
93"
93"
OVERALL LENGTH 22'-8$\frac{1}{4}$" NEW 23'-2$\frac{1}{2}$" WORN
21
13'-2"
34'-2"
13'-2"
21"
64'-0" OUTSIDE KNUCKLES


10'-6$\frac{1}{2}$" MAX.
JACKING PADS
JACKING OR LIFTING LUGS
JACKING LOCATION
10'-6$\frac{1}{2}$" MAX.
JACKING PADS
JACKING OR LIFTING LUGS.
JACKING PADS

WHEN BODY IS SUPPORTED BY JACKS IT MAY BE NECESSARY TO REMOVE AXLE DRIVEN GENERATORS, SPEED GOVERNOR OR TRAIN CONTROL RECEIVERS IF UNITS ARE SO EQUIPPED BEFORE REMOVING TRUCKS.

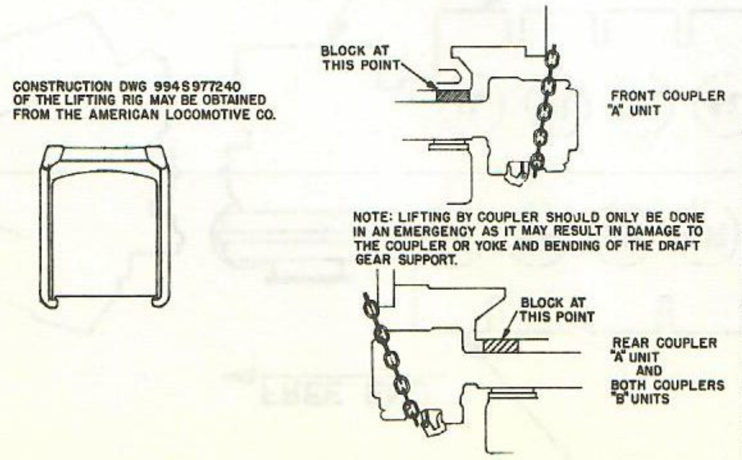
① JACKING AND LIFTING DATA WITH TRUCKS ATTACHED- SEE TABLE BELOW-LINES 1 THRU 8

② JACKING AND LIFTING DATA WITHOUT TRUCKS-SEE TABLE BELOW-LINE 9 THRU 12

"A" UNIT - MAXIMUM LOADED WEIGHT 320,000 LBS.

| LINE | JACK OR LIFT AT | FULCRUM | LOAD "A" | LOAD "B" | LOAD "C" | LOAD "D" | RAIL LOAD FT. TRUCK | RAIL LOAD BK. TRUCK |
|---|---|---|---|---|---|---|---|---|
| 1 | A | ℄ | 119,000 | — | — | — | — | 201,000 |
| 2 | B | C | — | 163,100 | — | — | — | 156,900 |
| 3 | C | B | — | — | 156,900 | — | 163,100 | — |
| 4 | D | B | — | — | — | 113,260 | 206,740 | — |
| 5 | A & C | — | 119,000 | — | 201,000 | — | — | — |
| 6 | A & D | — | 163,100 | — | — | 156,900 | — | — |
| 7 | B & C | — | — | 163,100 | 156,900 | — | — | — |
| 8 | B & D | — | — | 206,740 | — | 113,260 | — | — |
| 9 | A & C | — | 78,130 | — | 129,870 | — | — | — |
| 10 | A & D | — | 106,630 | — | — | 101,370 | — | — |
| 11 | B & C | — | — | 107,100 | 100,900 | — | — | — |
| 12 | B & D | — | — | 135,170 | — | 72,830 | — | — |

WEIGHT OF ONE MOTOR TRUCK COMPLETE 56,000 LBS.


BLOCK AT THIS POINT
FRONT COUPLER "A" UNIT
BLOCK AT THIS POINT
REAR COUPLER "A" UNIT AND BOTH COUPLERS "B" UNITS

CONSTRUCTION DWG 994S977240 OF THE LIFTING RIG MAY BE OBTAINED FROM THE AMERICAN LOCOMOTIVE CO.

NOTE: LIFTING BY COUPLER SHOULD ONLY BE DONE IN AN EMERGENCY AS IT MAY RESULT IN DAMAGE TO THE COUPLER OR YOKE AND BENDING OF THE DRAFT GEAR SUPPORT.

① JACKING AND LIFTING DATA WITH TRUCKS ATTACHED SEE TABLE BELOW. LINES 1 THRU 8

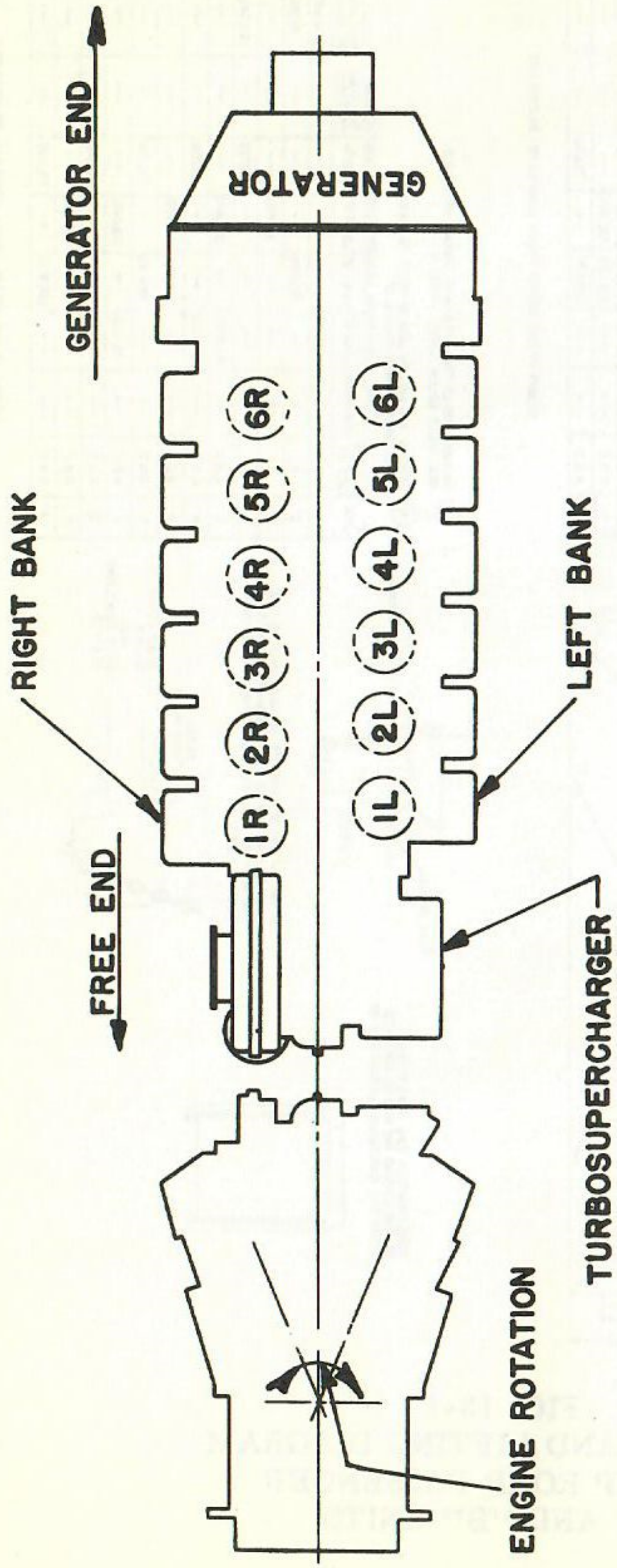
② JACKING AND LIFTING DATA WITHOUT TRUCKS-SEE TABLE BELOW LINES 9 THRU 12.

"B" UNIT - MAXIMUM LOADED WEIGHT 316,700 LBS.

| LINE | JACK OR LIFT AT | FULCRUM | LOAD "A" | LOAD "B" | LOAD "C" | LOAD "D" | RAIL LOAD FT. TRUCK | RAIL LOAD BK. TRUCK |
|---|---|---|---|---|---|---|---|---|
| 1 | A | C | 111,890 | — | — | — | — | 204,810 |
| 2 | B | C | — | 155,000 | — | — | — | 161,700 |
| 3 | C | B | — | — | 161,700 | — | 155,000 | — |
| 4 | D | B | — | — | — | 116,720 | — | 199,980 |
| 5 | A & C | — | 111,890 | — | 204,810 | — | — | — |
| 6 | A & D | — | 156,460 | — | — | 160,240 | — | — |
| 7 | B & C | — | — | 155,000 | 161,700 | — | — | — |
| 8 | B & D | — | — | 199,980 | — | 116,720 | — | — |
| 9 | A & C | — | 71,460 | — | 133,240 | — | — | — |
| 10 | A & D | — | 100,460 | — | — | 104,240 | — | — |
| 11 | B & C | — | — | 99,000 | 105,700 | — | — | — |
| 12 | B & D | — | — | 128,400 | — | 76,300 | — | — |

WEIGHT OF ONE MOTOR TRUCK COMPLETE 56,000 LBS.

FIG. 13-1
JACKING AND LIFTING DIAGRAM
2000 HP ROAD PASSENGER
"A" AND "B" UNITS


GENERATOR END
GENERATOR
RIGHT BANK
1R
2R
3R
4R
5R
6R
1L
2L
3L
4L
5L
6L
LEFT BANK
FREE END
TURBOSUPERCHARGER
ENGINE ROTATION

FIRING ORDER

1R-1L-4R-4L-2R-2L-6R-6L-3R-3L-5R-5L

FIG. 14-1

CYLINDER LOCATION

1500 HP ROAD & ROAD SWITCHER

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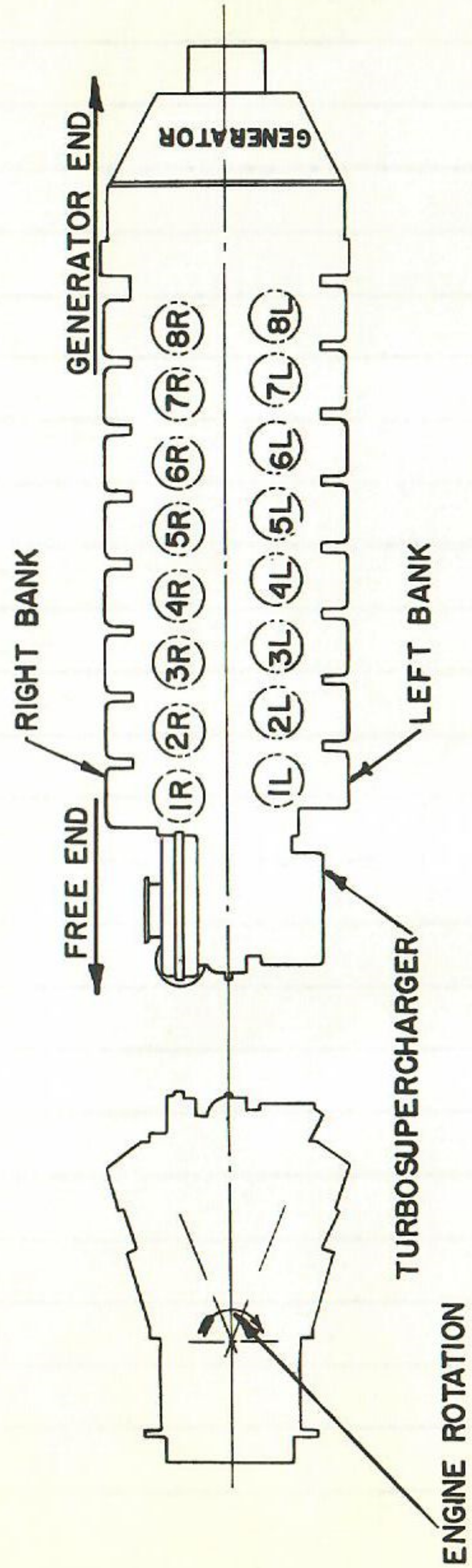
GENERATOR END
GENERATOR
RIGHT BANK
1R
2R
3R
4R
5R
6R
7R
8R
1L
2L
3L
4L
5L
6L
7L
8L
LEFT BANK
FREE END
TURBOSUPERCHARGER
ENGINE ROTATION

FIRING ORDER

1R-1L-5R-5L-7R-7L-3R-3L-8R-8L-4R-4L-2R-2L-6R-6L

FIG. 15-1

CYLINDER LOCATION

2000 HP ROAD LOCOMOTIVE

## NOTES

# FUEL OIL SYSTEM

## DESCRIPTION

The engine in each locomotive unit has an individual fuel system. Fig. 11-2. The fuel supply tank is located beneath the underframe between the trucks on the Road Locomotive and under the cab floor on the Road Switcher Locomotive.

A fuel oil booster pump draws fuel from the tank and then distributes it throughout the system.

The suction side is between the tank and the booster pump. All oil drawn from the tank must pass through the emergency fuel cutoff valve and fuel oil suction filter.

The pressure side is between the booster pump and the pressure regulating valve. As the fuel is discharged from the pump the regulating valve maintains 35 to 40 psi. However, as the oil flows through the system, it first passes by a pressure relief valve set for 75 psi, the purpose of which is to protect the booster pump, motor and system from overload. Oil then passes through a filter into the right bank fuel header which feeds the fuel injection pumps on the right side of the engine. It then crosses over at the generator end into the left bank header which feeds the left bank fuel injection pumps. The pressure regulating valve, located at the end of the left bank header, controls the fuel oil pressure in both headers. Ahead of this valve is the line connecting to the fuel oil pressure gauge on the Engine Control Panel.

## FUEL TANK FILLING

The fuel tank on the freight and passenger locomotives may be filled from either side at a rate of 250 GPM up to the top of the sight glass. On the road switcher, the rate may be 100 GPM up to the top of the sight glass.

sight gauge glass is provided to permit observation of the fuel level on the side of the tank to prevent overflowing. The tank is equipped with two vent pipes with flame arrestors. The fuel tank capacity on the Road Locomotive is 1200 gallons. On the Road Switcher the tank capacity is 800 gallons.

## FUEL TANK DRAINING

The tank is equipped with drain plugs for wash-out purposes and also a water drain valve. The water drain valve is an inverted type held in place by a cap nut. Remove the pipe plug in the side of the cap nut and then loosen the cap nut a few turns. This will allow the valve to drop from its seat and condensation to drain through the hole in the cap nut. Tighten cap nut and apply pipe plug.

## REMOTE FUEL LEVEL INDICATOR

Road Locomotives are equipped with a remote gauge which indicates the fuel level in the tank in gallons and inches and operates on 10 lbs. of air pressure. Keep the air supply valve closed except when taking a reading in order to maintain gauge accuracy and to prevent condensation from getting into the fuel tank.

## EMERGENCY FUEL CUTOFF VALVE

The Emergency Cutoff Valve, Fig. 1-2, furnishes a means of shutting off the flow of fuel from the tank to the Diesel engine in case of fire. This valve is located in the suction line near the tank. Five knobs are furnished to trip this valve on the Road Locomotive and three on the Road Switcher Locomotive. The five knobs on the Road Locomotive are located -- one in the cab behind the engineer, one on each of the side walls near the doors in the engine room and one on each side of the fuel tank which may be reached from the ground. The three on the Road Switcher are located -- one in the cab and one on each side of the locomotive near the center of the underframe which may be reached from the ground.

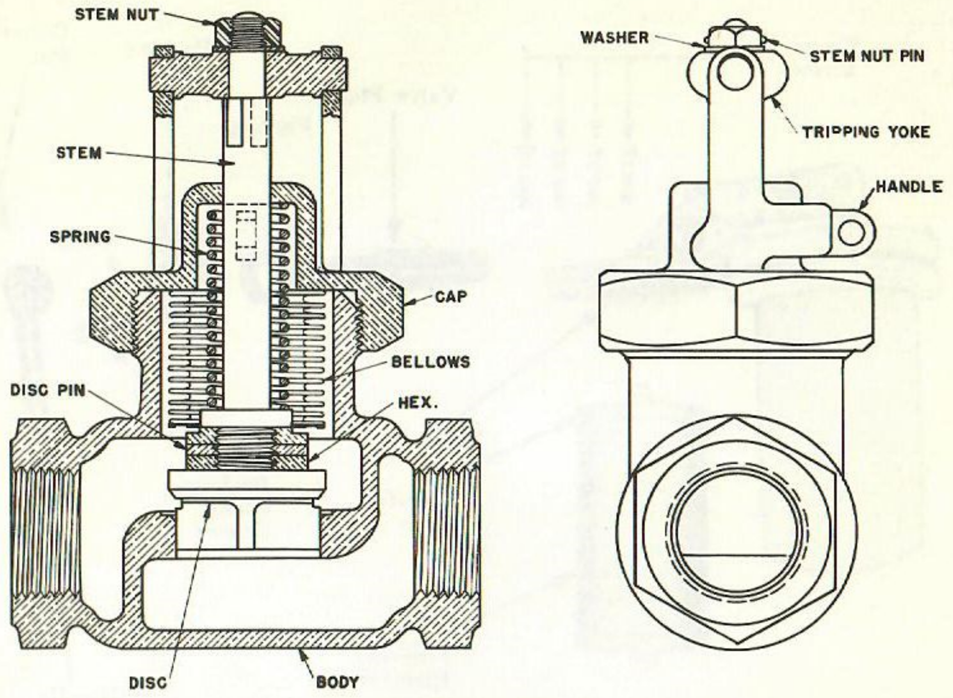

FIG. 1-2
EMERGENCY FUEL CUTOFF VALVE

When the valve is tripped the fuel pressure gauge on the Engine Control Panel should indicate zero pounds pressure. Reset manually by pulling up on the valve stem and reset the crutch which holds the valve open.

## DUPLEX FUEL FILTER

The Duplex Filter, Fig. 2-2, consists of two filtering elements each containing one pound of filtering material. The filter handle controls the flow of fuel through either one of the two elements or both. With the handle in a horizontal position one element is in use; with it in the vertical position, both elements are in use. Normal position for the handle is horizontal. With the handle in a 45° position, no fuel will flow through the filter.

If there is a gradual drop in fuel pressure, the indication is that the element in use is plugging up and the handle should be moved to the opposite horizontal position.

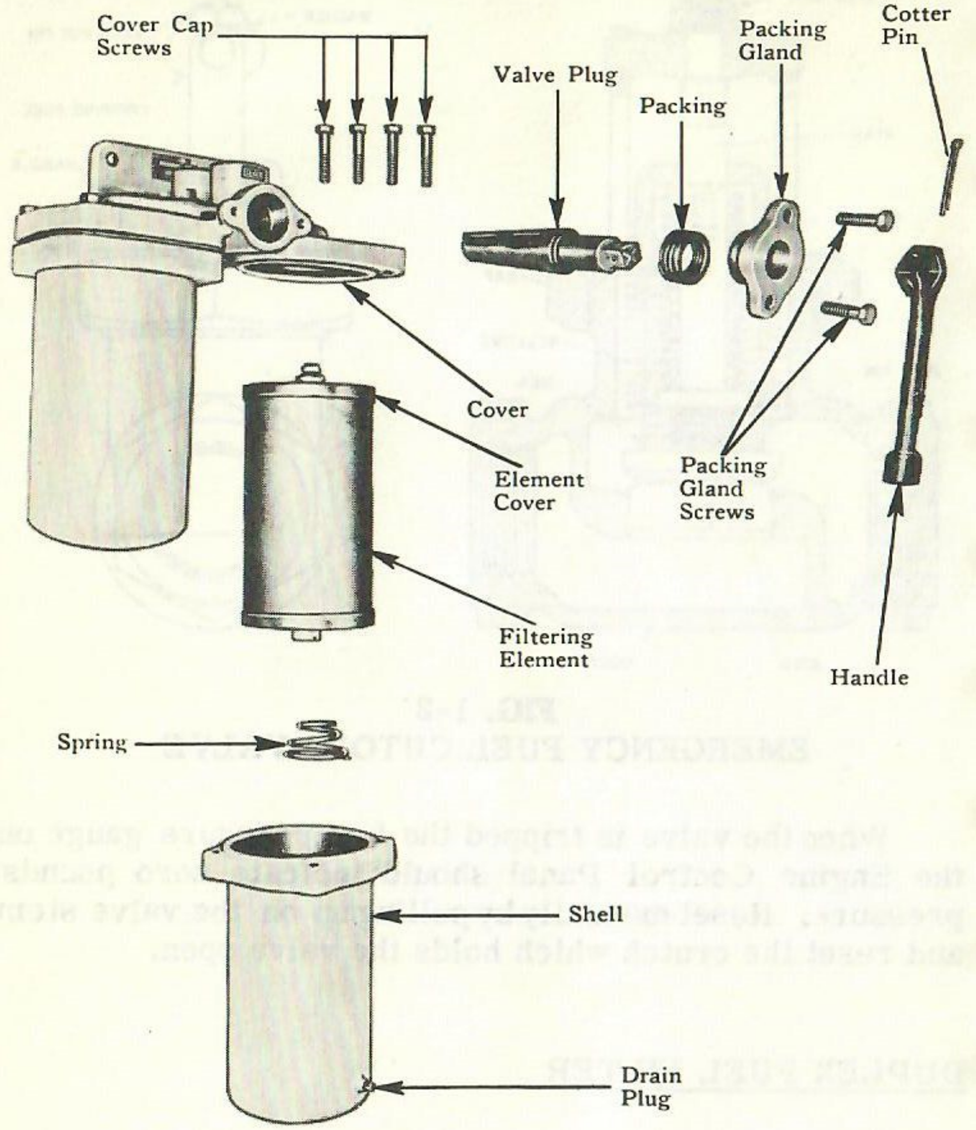
Cover Cap Screws
Valve Plug
Packing
Packing Gland
Cotter Pin
Cover
Element Cover
Packing Gland Screws
Filtering Element
Handle
Spring
Shell
Drain Plug

FIG. 2-2
DUPLEX FUEL FILTER

## FUEL BOOSTER PUMP

The fuel booster-governor pump assembly consists of an electric motor driving a gear type fuel booster pump through a flexible coupling on one end of its shaft and a gear type governor oil pump through another flexible coupling on the other end of its shaft. The brushes for the motor are located at the fuel pump end of the motor.

---

There are two types of fuel booster pumps in service, namely,

Rotation CCW-1725 RPM - 3 GPM - 50psi - 1L -X75-ACC
Rotation CCW-3450 RPM - 3 GPM - 50psi - 1L -X75-A

## RELIEF VALVES

There are two relief valves, Fig. 3-2, used in the system, one set at 75 psi to protect the booster pump motor from overload and the other to regulate the pressure at 35-40 psi.

Both valves are adjusted by removing the valve cap and turning the adjusting screw in to raise the pressure and out to lower the pressure.

A sudden drop in the fuel oil pressure when the throttle is opened would indicate a sticky pressure regulating valve.

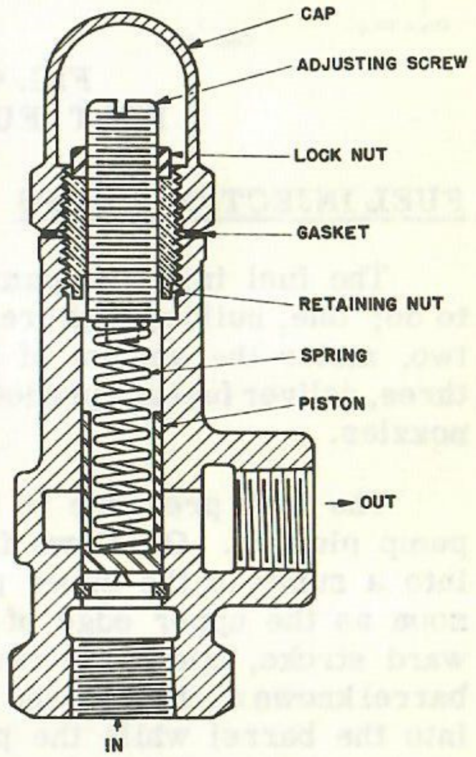
CAP
ADJUSTING SCREW
LOCK NUT
GASKET
RETAINING NUT
SPRING
PISTON
OUT
IN

FIG. 3-2
RELIEF VALVE

## FUEL FILTER

The filtering material in the pressure filter, Fig. 4-2, consists of a number of felt discs assembled on a steel tube strainer. This filter may be cleaned by repeatedly dipping the felts into fuel oil or kerosene, holding hand over bottom of stack and blowing dry compressed air from the inside until the felt appears to be clean.

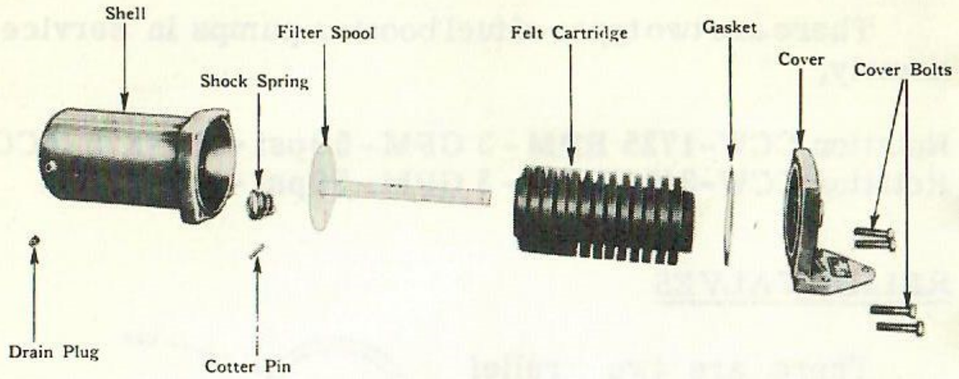
Shell
Filter Spool
Felt Cartridge
Gasket
Cover
Cover Bolts
Shock Spring
Drain Plug
Cotter Pin

FIG. 4-2
FELT FUEL FILTER

## FUEL INJECTION PUMPS

The fuel injection pumps, Fig. 5-2, have three jobs to do; one, build up high pressure to the injection nozzles; two, meter the amount of fuel to the injection nozzles; three, deliver fuel at a predetermined time to the injection nozzles.

The high pressure is built up by a constant stroke pump plunger. Oil flows from the low pressure header into a sump in the upper part of the pump housing. As soon as the upper edge of the plunger, during its downward stroke, opens the two radial opposite ports in the barrel known as the inlet and by-pass ports, the fuel flows into the barrel while the plunger is at the bottom of its stroke. During the first part of the upward stroke of the plunger some of the fuel in the barrel is forced back into the sump through the inlet and by-pass ports until these ports are closed by the double helix cut in the plunger. The plunger then builds up high pressure within the barrel, unseats the delivery valve and forces oil through the high pressure pipe to the injection nozzle.

The amount of fuel delivered to the nozzle depends upon the lift required for the helix to open the by-pass port. This is controlled by the fuel pump rack which moves in and out, turning the plunger through a control sleeve so as to give an earlier or later port opening.

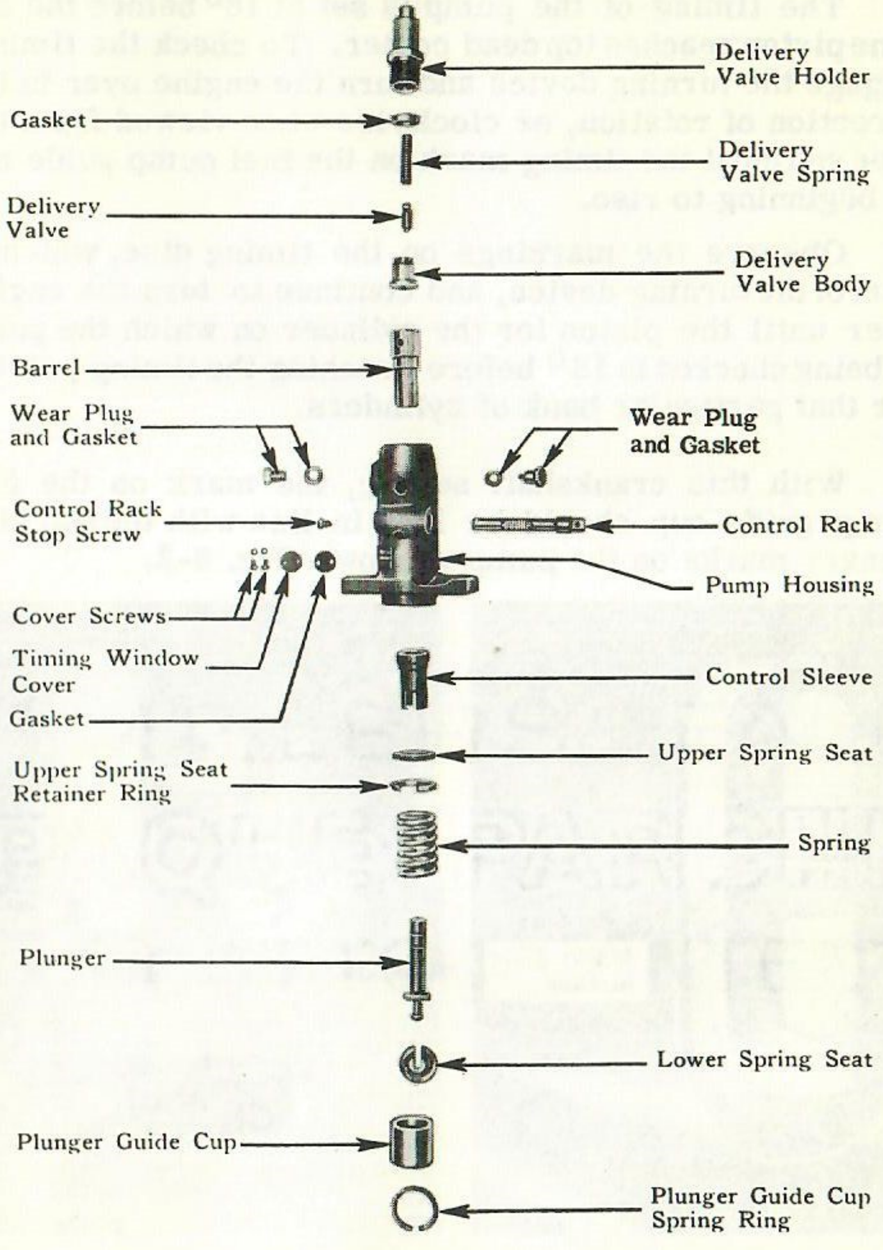
Delivery Valve Holder
Gasket
Delivery Valve Spring
Delivery Valve
Delivery Valve Body
Barrel
Wear Plug and Gasket
Wear Plug and Gasket
Control Rack Stop Screw
Control Rack
Pump Housing
Cover Screws
Timing Window Cover
Gasket
Control Sleeve
Upper Spring Seat
Upper Spring Seat Retainer Ring
Spring
Plunger
Lower Spring Seat
Plunger Guide Cup
Plunger Guide Cup Spring Ring

FIG. 5-2
FUEL INJECTION PUMP

## FUEL INJECTION PUMP TIMING

The timing of the pump is set at 18° before the engine piston reaches top dead center. To check the timing, engage the turning device and turn the engine over in the direction of rotation, or clockwise when viewed from the free end until the timing mark on the fuel pump guide cup is beginning to rise.

Observe the markings on the timing disc, which is part of the turning device, and continue to turn the engine over until the piston for the cylinder on which the pump is being checked is 18° before reaching the timing pointer for that particular bank of cylinders.

With this crankshaft setting, the mark on the fuel pump guide cup should be line-in-line with the two stationary marks on the pump window. Fig. 6-2.

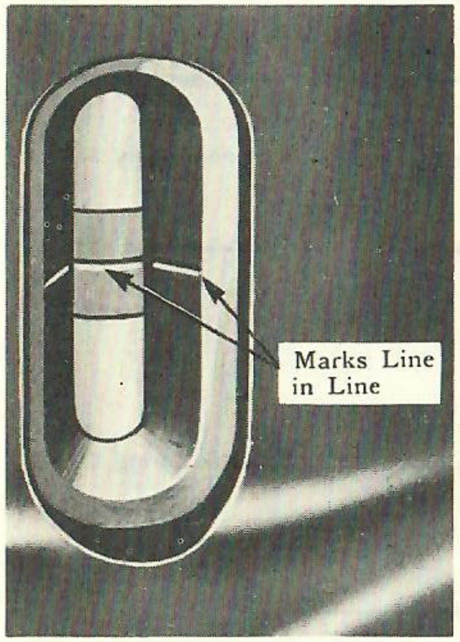

FIG. 6-2
PUMP TIMING

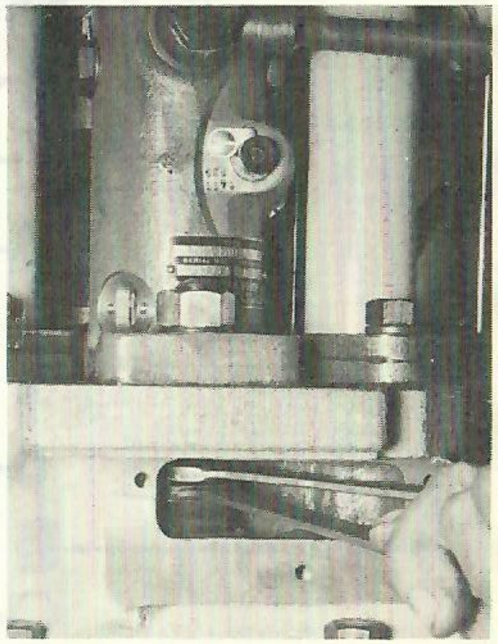

FIG. 7-2
ADJUSTING PUMP TIMING

If not line-in-line remove the cover plate on the front of the injection pump mounting base, loosen the lock nut and turn the adjustable tappet until the timing marks on the pump are line-in-line. Fig. 7-2. Tighten lock nut.

## DELIVERY VALVE

A delivery valve and seat is located on top of the pump housing and is held in place by a large holding nut and gasket. If leakage should occur around the delivery valve holder, apply a new gasket or anneal the old one.

There is no gasket between the face of the delivery valve and the plunger barrel. This is a ground joint and should be carefully guarded against damage if taken out.

## FUEL INJECTION PUMP CUTOUT

A cutout latch is provided for each fuel injection pump. Fig. 8-2. Push in the pump rack and flip the latch over to prevent movement of the spring-loaded operating lever. In this position, the pump will not deliver fuel.

No more than two pumps may be cut out at any one time. If more than two pumps are cut out, the action of the governor may be abnormal.

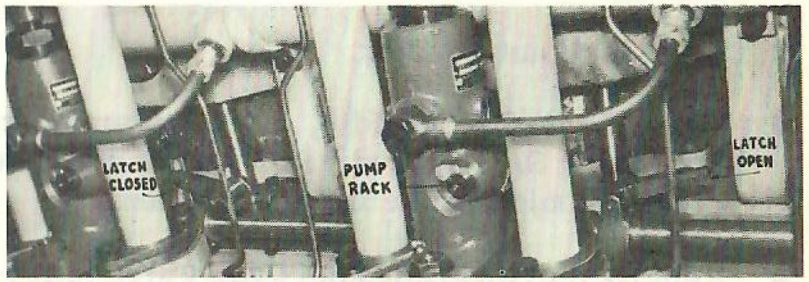

FIG. 8-2
FUEL PUMP CUTOUT

## CHECKING FUEL INJECTION PUMP OUTPUT

When there is any question about pump output, a simple check may be made to determine the trouble. Place the pump on a test rack and apply a 10,000 psi gauge to the fuel pipe connection on the delivery valve holder. Work the pump by hand and observe the action on the gauge. The pump should maintain 6000 psi. If the pump does not pump up to the 6000 psi pressure or the leakoff is rapid, either the delivery valve seat is leaking or the pump plunger and barrel is worn. Grind in the delivery valve first and then recheck the pump on the tester. If this does not improve the pump action, the plunger and barrel should be renewed. Replacement of such parts require calibration and the pump should be returned to the manufacturer for this type of work.

## FUEL INJECTION PUMP IDENTIFICATION

Body Marking - APF 1 CC 170 T 1832 A, B or C
or
APF 1 C 170 T 1760 B or C

## FUEL INJECTION PUMP RACK SETTING - DRY RUN

A dry run is a means of checking maximum fuel pump rack travel with the Diesel engine shut down. Rack adjustments may be made in accordance with the following:

1. Block GS 1, GS 2 open; Block OPS 1 and OPS 2 closed.

2. Start fuel pump motor.

3. Turn EC switch to Idle, turn on starting switch and block SAR closed. Release starting switch. Racks should now be in Idle position.

4. Remove the Governor Fuel Pilot Valve cover. This is the one toward the center of the engine.

5. Check for 10 mm. differential between full load and Idle position rack travel. When pushing down on the pilot valve, full rack travel will be obtained; releasing the pilot valve will give rack travel at Idle. The differential is adjusted by increasing or decreasing the length of the vertical lever that connects onto the fuel control shaft. Increasing the length of the vertical lever decreases the differential; decreasing the length, increases the differential. If any adjustments have been made, ream and redowel the levers.

6. Check for 24 mm full rack travel. Try the individual pump racks for stickiness. Individual pump rack should be adjusted to obtain 24 mm. To adjust one bank of pumps as a unit, adjust the horizontal lever to obtain 24 mm, ream and redowel. A setting of 24 mm full rack travel should give 14 mm in Idle on dry run.

7. Recheck maximum rack travel of all pumps after both banks of pump racks have been adjusted.

## FUEL INJECTION NOZZLES

The fuel injection nozzles, Fig. 9-2, are located in the cylinder heads. Their function is to admit fuel into the combustion space in a finely atomized condition and distribute the spray so that each particle will come in contact with sufficient oxygen for complete combustion.

Oil is fed to the nozzle from the fuel injection pump through tubing to the fuel inlet connection at the top of the nozzle holder body and down a drilled passage in this body which connects with a machined groove on top of the nozzle. Drilled passages lead from this groove to the underside of the nozzle valve.

As the fuel pressure from the pump builds up, the valve in the nozzle is raised from its seat and injection of fuel begins. When the pressure, timed from the cam under the pump, drops below the pressure at which the spring has been set, the valve returns to its seat.

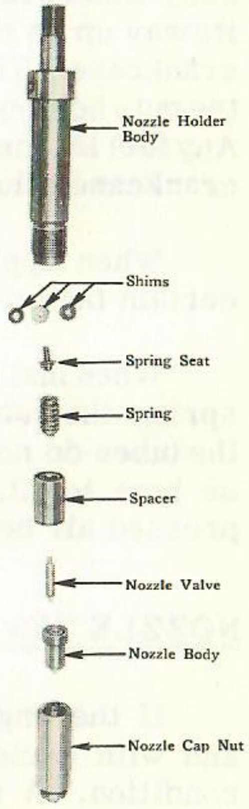

FIG. 9-2
NOZZLE

The valve has a very fine fit in the nozzle body and any leakage finds its way into the nozzle holder and is drained through a pipe connecting the nozzle drain to the fuel tank. A small amount of leakage is desirable as this is a means of lubricating the valve in its fit in the nozzle body.

## ASSEMBLING NOZZLES AND TUBES

One of the worst possible engine failures can be caused by fuel leaking into the crankcase and caution must be used in correctly tightening the following and inspecting and checking for fuel leakage. The nozzle cap nut, if not tight will leak large amounts of fuel into the crankcase. The nozzle spacer must have a perfect lapped fit where it contacts the valve body and the nozzle holder body otherwise fuel will leak past these joints and work its way up on to the cylinder head and drain back into the crankcase. The fuel leak off stud must be tight as well as the nuts holding the injection and drain tubes to the holder. Any fuel leak inside the valve mechanism casing will cause crankcase dilution.

When applying a nozzle in the cylinder head make certain the nozzle gasket is in place.

When installing fuel tubes, care must be taken not to spring the tube to catch it on the nozzle connection. If the tubes do not line up with their connections, they must be bent to fit. Bend cold and blow out with dry compressed air before application.

## NOZZLE TESTING

If the engine is to operate smoothly, economically and with a clear exhaust, the nozzle must be in perfect condition. A nozzle testing outfit, Fig. 10-2, has been developed using a spare injection pump, so that the condition of the nozzle can be determined. The holes in the nozzle tip should show even sprays, finely atomized. Many nozzles will give a loud squeaking sound (known as chattering) as the fuel is forced through the holes in the nozzle tip. This spray should be sharply cut off, and if there is any dribble, the nozzle should be returned to the manufacturer for reconditioning.

If any one of the small holes in the nozzle tip are found to be plugged, it may be cleaned with the small wire cleaner. If the plugged hole can not be cleared, the nozzle should be returned to the manufacturer for reconditioning.

A sticky needle valve should be freed, lapped into the body and then retested. Return the nozzle to the manufacturer if the needle valve cannot be freed.

To check the opening pressure of a nozzle assembly, the operator attaches it securely to the injection tube on the test rack. The fuel pump rack should be set at approximately 20 mm travel. Test the nozzle by pumping the lever steadily until fuel discharges and at the same time note the pressure indicated on the gauge. The opening pressure of the nozzle may be determined by the gauge reading.

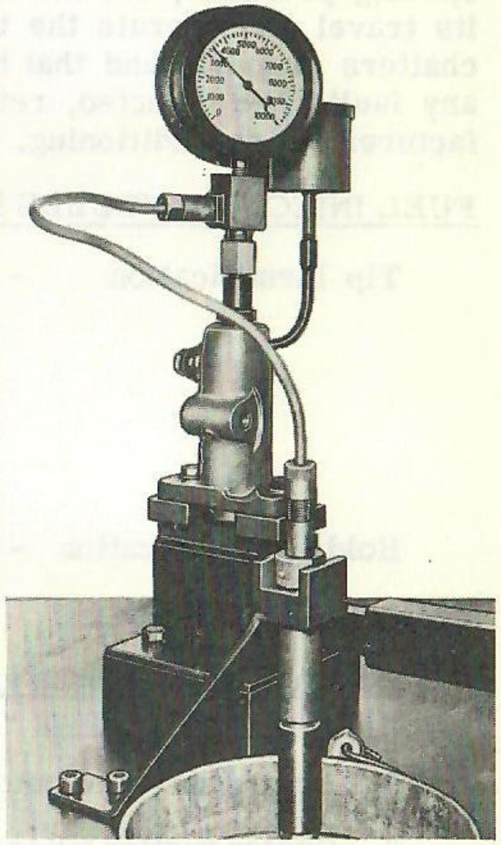

FIG. 10-2
NOZZLE TESTER

The handle should be pumped very slowly when checking the opening pressure. The minimum pressure required to give a very tiny spray is the opening pressure. The pressure should be held steadily at about 100 psi less than the opening pressure for a period long enough to observe if there is any leakage at the nozzle seat.

Do not operate the lever quickly as this will cause extremely high pressure to be built up, giving an unreliable gauge reading. Pressure adjustment is made by increasing or decreasing the amount of shim stock which varies spring tension. The nozzle operating pressure is 3600 psi.. However, nozzles that have been reconditioned should be set at 3800 psi and new nozzles are set at approximately 4000 psi, as the pressure will settle to 3600 psi after operating in the engine a short time.

After the nozzle assembly has been set at the proper opening pressure, set the fuel pump rack at the limit of its travel and operate the test rig to see if the nozzle chatters properly and that there is no after-dribble. If any faults are detected, return the nozzle to the manufacturer for reconditioning.

## FUEL INJECTION NOZZLE IDENTIFICATION

Tip Identification - ADL 165 TL 606
9 - .375

or

ADL 165 TM 606
9 - .375

Holder Identification - AKK 200 T 1858 A

## FUEL PROBLEMS

A. If the fuel oil pressure gauge indicates low pressure with the pump running -

1. Emergency fuel cutoff valve tripped.
2. Duplex suction filter is dirty or packed too tightly. It is possible to change a filter from one unit which has filters in good condition to another without causing a road delay. The filter handle may be used to loosen the cap screws from the filter.
3. Defective booster pump.
4. Suction pipe leaking.

5. Plugged or broken pipes. If an engine has fuel leaking from the nipple at the junction of a cylinder low pressure line and the fuel header, ascertain whether the pipe flange or the nipple is at fault. If replacement parts are not available, the leak is best stopped by plugging the header with an ordinary pipe plug or a suitable wooden plug. To prevent fuel injection pump from overheating turn adjustable tappet down until pump becomes inoperative.
6. Stuck relief or pressure regulating valve.
7. Pressure filter dirty.
8. Defective pressure gauge.

B. If the fuel oil pressure gauge indicates zero pressure-

1. Fuel booster pump not operating.
2. Battery switch not closed.
3. Control positive and negative circuit breakers in off position.
4. Fuel pump circuit breakers and switch in off position.
5. Defective fuel oil pressure gauge.
6. Defective booster pump motor.
7. Broken booster pump coupling.
8. Defective booster pump.
9. Emergency fuel cutoff valve tripped.
10. Broken fuel pipes.
11. No fuel.
12. Duplex suction filter handle not in vertical or horizontal position.

C. Fuel injection pumps should be cut out -

1. Excessively hot pump.
2. Stuck rack.
3. Broken injection tubing.
4. Broken delivery valve spring.
5. Broken guide cup spring.
6. Injection nozzle stuck open or closed.

D. To eliminate or cut down leaks in the low pressure fuel lines -

1. Loosen all line connections both at the header and at the pump.
2. Loosen all header clamps so that the header is free to locate itself.
3. Retighten all line connections at the header and at the pump.
4. Retighten the header clamps. This procedure will allow the fuel header to take a position which imposes the least strain on the fuel lines and has helped, in several cases, to eliminate fuel line difficulties.

## DELIVERY VALVE HOLDING NUT

In tightening the delivery valve holding nuts on the APF1C and CC fuel injection pumps, it is recommended that the holders be worked into the delivery valve holder gaskets by progressively loosening and tightening the delivery valve holder until the following approximate torques have been obtained:

| | | |
|---|---|---|
| APF1C | - - - - - - - - | 240 - 270 Foot Pounds |
| APF1CC | - - - - - - - - | 450 - 500 Foot Pounds |

## FUEL OIL SPECIFICATIONS

A.S.T.M. 2-D except a minimum flash point of 120° F.

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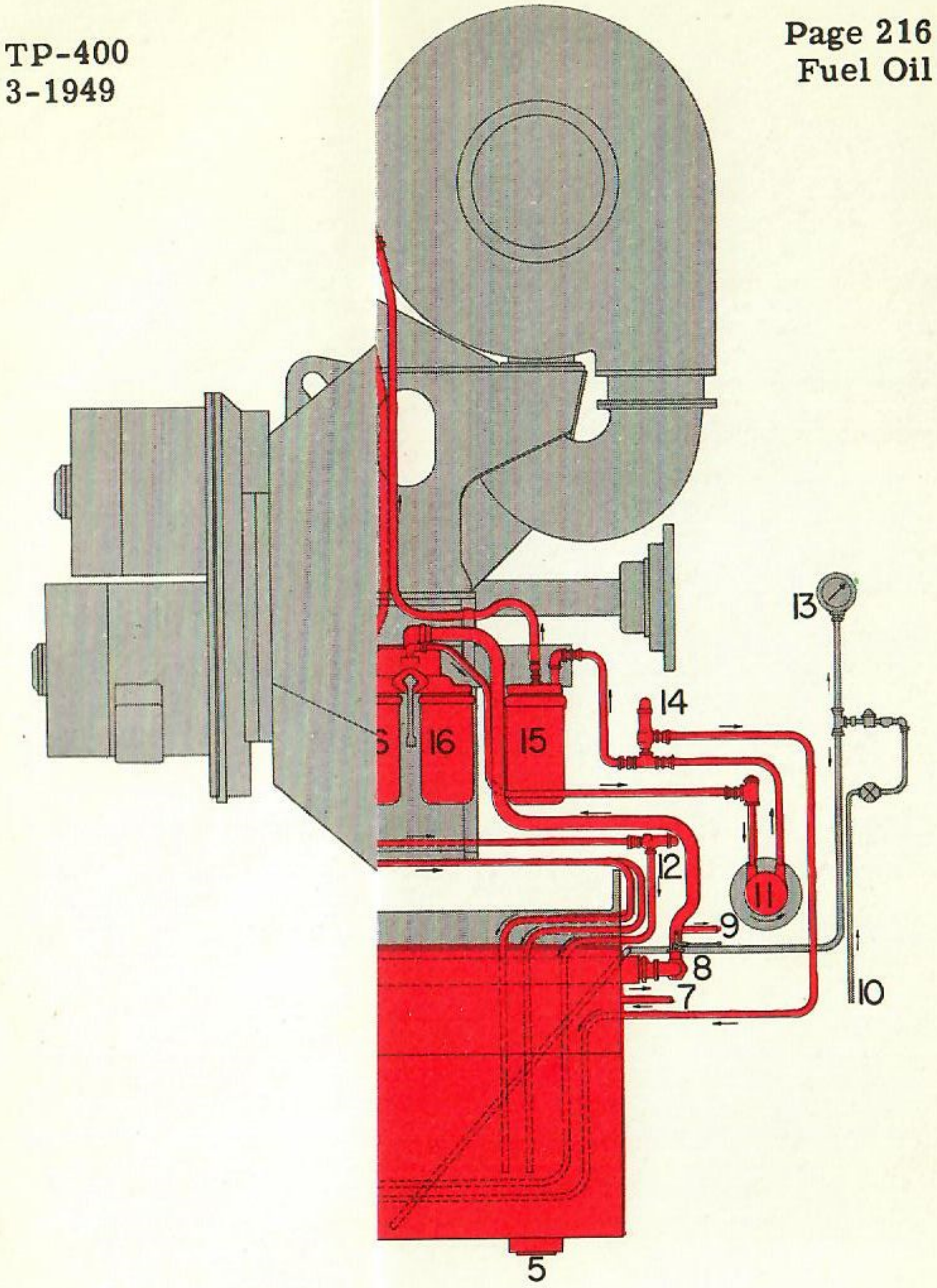
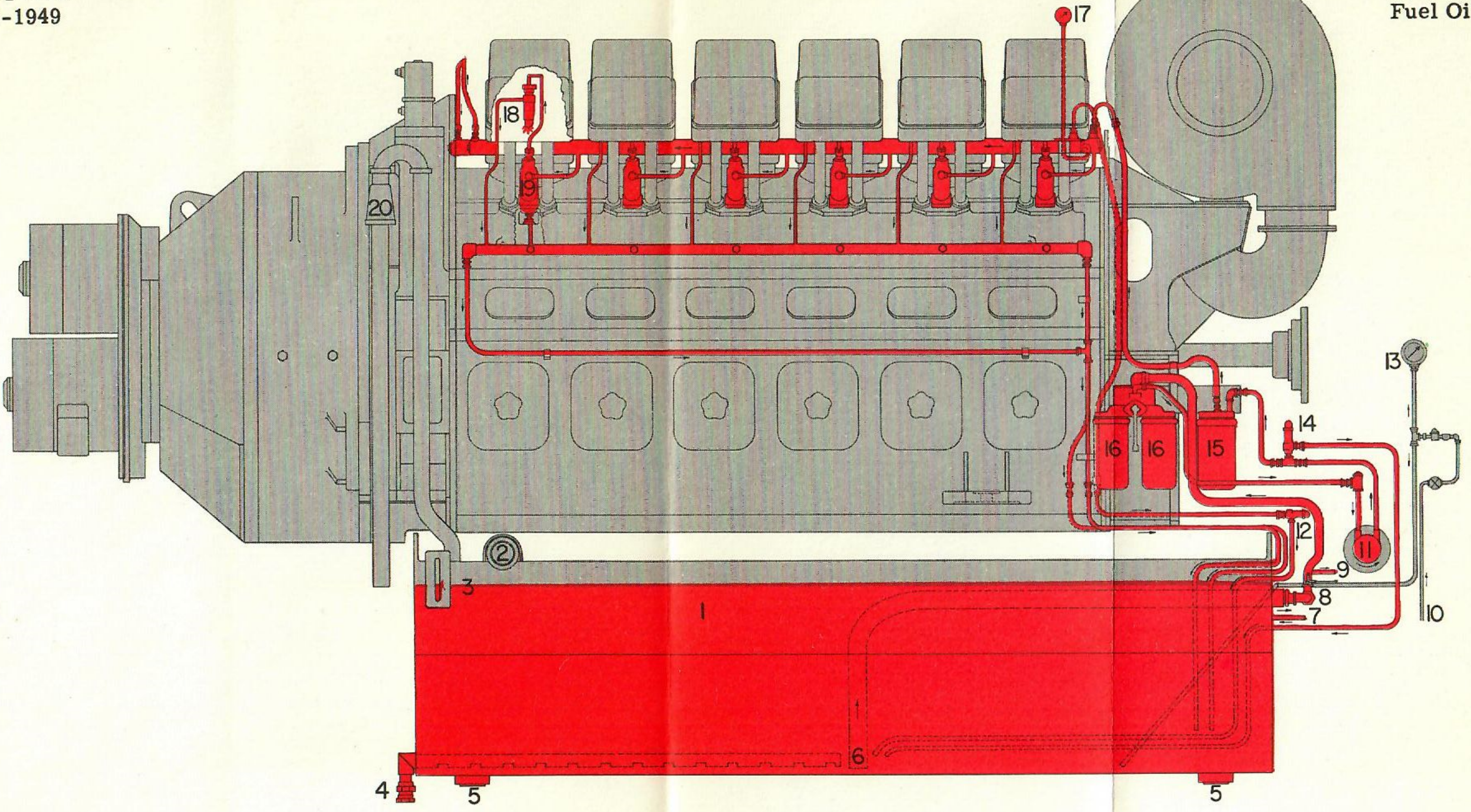


**1. Fuel Tank**
**2. Filling Connection**
**3. Tank Sight Gauge**
**4. Tank Water Drain Va**

**icator**
**Valve**
**Duplex)**

**17. Pressure Gauge**
**18. Injection Nozzle**
**19. Injection Pump**
**20. Vent and Flame Arrester**

FIG. 11-2
FUEL OIL SYSTEM



1. Fuel Tank
2. Filling Connection
3. Tank Sight Gauge
4. Tank Water Drain Valve
5. Washout Plugs
6. Supply to Engine
7. Return from Steam Generator
8. Emergency Cutoff Valve
9. Supply to Steam Generator
10. Air Supply for Tank Level Indicator
11. Fuel Booster Pump
12. Pressure Regulating Valve
13. Tank Level Indicator
14. Pressure Relief Valve
15. Pressure Filter
16. Suction Filter (Duplex)
17. Pressure Gauge
18. Injection Nozzle
19. Injection Pump
20. Vent and Flame Arrester

FIG. 11-2
FUEL OIL SYSTEM

# LUBRICATING OIL SYSTEM

## DESCRIPTION

The engine in each locomotive unit contains its individual lubricating system, Fig. 2-3. All working parts are pressure lubricated by a gear type pump gear driven from the engine crankshaft. The engine is classified as a wet sump type since all the lubricating oil is stored in the engine base. This oil is hot and dirty as it has cleaned, cooled and lubricated the various working parts on its course through the engine. Therefore, means must be provided to clean and cool the oil before it is returned to the engine.

With the engine operating, the lubricating oil pump draws this hot and dirty oil from the base and discharges to the system under high pressure. This pressure is regulated by a pressure regulating valve mounted in the pump discharge line. The oil is then passed through a filter where it is cleaned but since it is still hot, it is piped to a cooler where a portion of the heat is absorbed by the engine cooling water. From the cooler, the oil is piped to a strainer where any remaining impurities are removed and then delivered to the main header of the engine. Just before the oil enters the main header, a portion of the oil is piped to the valve lever mechanism, camshaft bearings, gear trains and turbosupercharger bearings, returning to the engine base through various drain lines.

Individual jumper pipes conduct the oil from the main header to each main bearing. Drilled passages in the crankshaft allows the oil under pressure to flow from the main bearing journals to the connecting rod bearing journals. From the connecting rod bearings, the oil passes up through rifled drilled connecting rods to hollow full floating piston pins lubricating the piston pin and bushing. Through a passage in the main pistons, oil flows from the piston pins to oil cooling grooves in the pistons terminating in an outlet hole and draining back to the engine base.

At the end of the main engine header, a line leads to the engine control panel terminating in a pressure gauge and two low oil pressure switches which protect the engine against loss of lubricating oil pressure.

## FILLING AND DRAINING

The total system capacity is 200 gallons on the 1500 HP Road Switcher and Road Freight and 230 gallons on the 2000 HP Road Passenger locomotives.

To fill the system, any engine base door can be removed and the oil poured in through this opening. A filling connection is supplied at the free end of the engine for the addition of make-up oil. Never remove a base door while the engine is operating as hot oil, thrown from the rotating parts, may cause personal injury.

The system is drained by removing the pipe cap from an external drain pipe and the drain plug in the engine base. In addition, there are three drain valves to open, one for the strainer and two for the filter.

A bayonet gauge is provided with a HIGH and LOW mark to determine when oil should be added to the system. The gauge should be checked daily with the level maintained between the high and low mark, preferably at the high, with the engine idling on a level track, crankcase exhauster shut off and the oil temperature near normal. Make certain the crankcase exhauster is turned on and operating after an oil check.

If the level of the lubricating oil is found to be above the base screens, with the oil level at the high mark on the gauge, the markings on the bayonet gauge should be checked and remarked as follows: "High" mark 9-7/8" from the shoulder at the knob end of the gauge - "Low" mark 12-7/8" from the shoulder at the knob end of the gauge.

## LUBRICATION OIL PUMP

The lubricating oil pump is of the positive displacement type employing a pair of helical spur gears as rotors. It is mounted on the free end casing and gear driven from the engine crankshaft through a spline arrangement. In mounting a pump to an engine no precautionary measures are required as a boss on the back of the pump assembly assures positive alignment. Make certain that the thrust washer is applied to the spline end of the pump before mounting.

## PRESSURE REGULATING VALVE

The lubricating oil pressure in the system is controlled by an adjustable spring loaded regulating valve located on the discharge side of the lubricating oil pump. The spring pressure is regulated by means of an adjusting screw which is held in place by a lock pin and protected by a lock cap. Therefore, to adjust the lubricating oil pressure, remove the cap and locking pin and turn adjusting screw clockwise to raise the pressure and counterclockwise to decrease the pressure.

The pressure should be 45-55 psi at full engine speed as shown on the gauge on the engine control panel. Therefore, when any work is done on the regulating valve, the bench setting should be 80-85 psi. This is done to allow for line loss through the system remembering that the gauge pressure is taken at the end of the main header or end of the system. However final pressure adjustment of 45-55 psi should be made on the locomotive with full engine speed.

## FILTER

The lubricating oil filter contains eight filter elements each equipped with a 5/16" orifice to maintain approximately a 20 psi pressure drop across the filter and to insure a definite quantity of oil for the engine. Each filter element contains a sock type filter cartridge or it may be packed with 7½ pounds of long strand cotton waste after installation of center tube. In changing filters, open the upper filter drain valve to eliminate as much oil as possible before removing the cover. Both filter drain valves must be open in draining the entire lubricating oil system. The filter is equipped with a vent line to eliminate any formation of air pockets in the filter housing. When applying clean filters, correctly position elements in filter casing, close the drain valves, and completely fill with clean engine lubricating oil. Approximately 30 gallons is required. Replace filter housing cover, making certain that the cover gasket is in good condition, clean and firmly seated in the bottom of the gasket groove. Filter elements should be repacked periodically to keep the lubricating oil clean. Any formation of sludge on these elements warrants an immediate oil and filter change.

## COOLER

The lubricating oil cooler is a heat exchanger of the vertical shell and tube type. One cooler is provided for each engine consisting of a bundle of tubes rolled into tube sheets which in turn are welded to the shell.

Cooling water from the radiators flows into the top end cover of the unit, down through the tubes and out at the bottom. The hot lubricating oil enters at the bottom of the shell, circulates back and forth across the tubes and leaves the cooler at the top. During this process heat is removed from the oil due to its contact with the tubes, through which the cooling water if flowing. Baffles are provided inside the shell to channel the oil flow in the most efficient manner.

## TO CLEAN COOLER TUBES

1. Inside Tubes (Water Side)

   Access to the water side of the tubes can be obtained by unbolting the end flanges and removing the end covers. Soft scale may be removed by means of brushes. Should hard scale be present tube cleaners may be used. Observe care in handling tubes as they are of a very thin wall.

2. Outside Tubes (Oil Side)

   The oil side of the tubes may be cleaned by steaming out or by circulating a cleaning fluid through the pipe connections provided at each end of the shell. Before cleaning is started, it is necessary to drain oil from the pipe tap in the bottom shell flange and to blank off oil inlet and outlet lines.

Experience indicates that the oil side of the cooler tubes should be cleaned once a year, or more often as service conditions may require. Cleaning can be done quickly without removing the cooler from the locomotive by using one hundred (100) gallons of cleaning solution heated and passed by steam through the oil side as follows:

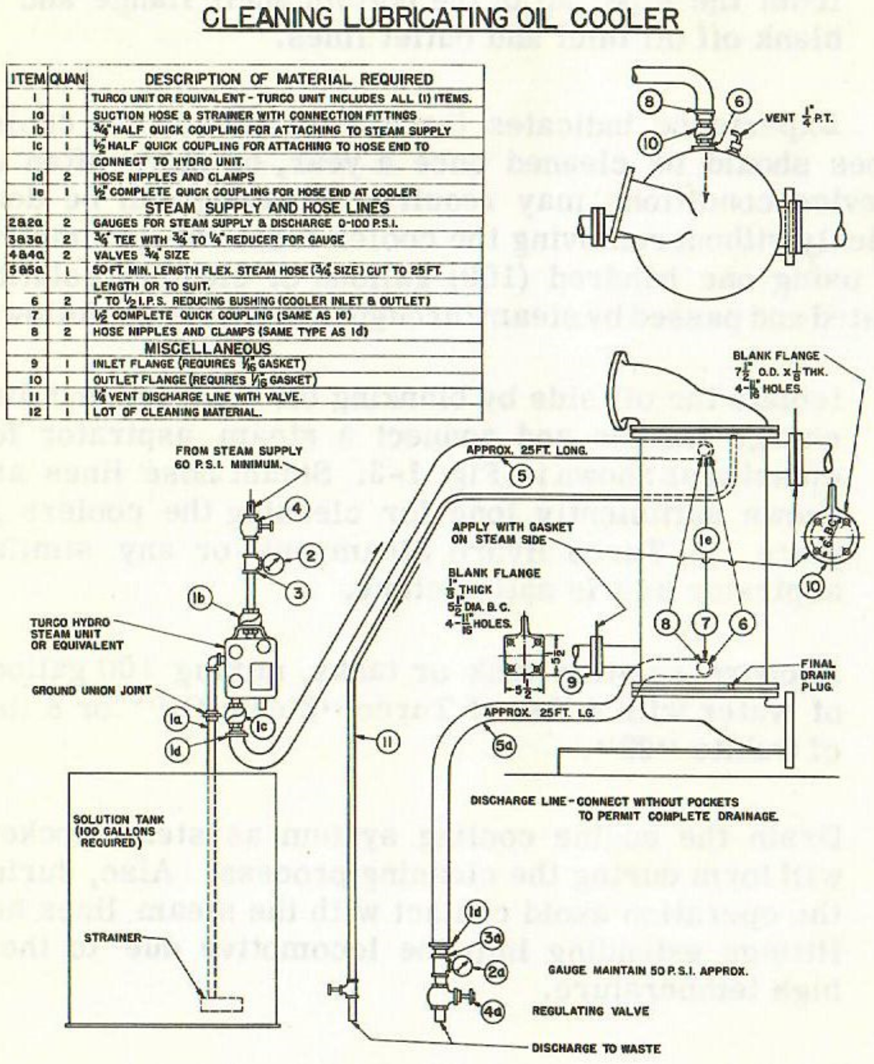
1. Isolate the oil side by blanking off the inlet and discharge flanges and connect a steam aspirator for cleaning as shown in Fig. 1-3. Steam hose lines are shown sufficiently long for cleaning the coolers in place. A Turco Hydro Steam unit or any similar aspirator unit is satisfactory.

2. Prepare solution tank or tanks, mixing 100 gallons of water with 4 lbs. of Turco "Steam Off" or 8 lbs. of Oakite "92".

3. Drain the engine cooling system as steam pockets will form during the cleaning process. Also, during the operation avoid contact with the steam lines and fittings extending into the locomotive due to their high temperature.

4. Fill the cooler with cleaning solution by closing the discharge valve from the cooler, opening the vent valve and opening the steam supply valve gradually. It is necessary to first fill the cooler with the solution and to keep the cooler full during the cleaning process in order to clean the full length of tubes.

5. After the solution is passed through the cooler once, it is then discharged as waste. Pressure in the cooler should be maintained as near 50 psi as possible (do not exceed 75 psi), the rate of flow held to 2 GPM approximately or about six hours to pass all the solution through, and the cooler kept full during the operation. Careful observation and care in operating all the valves will permit this to be done. In general keep the vent line open as material flowing from the vent line shows the cooler to be full. The discharge valve will govern steam pressure but a differential must be maintained between it and the steam supply valve. The valves on the aspirator should be regulated to get proper quantity of solution to flow with the steam.


CLEANING LUBRICATING OIL COOLER
VENT 1/4" P.T.
8
6
10
BLANK FLANGE
7 1/2" O.D. X 1/8 THK.
4-11/16" HOLES.
FROM STEAM SUPPLY
60 P.S.I. MINIMUM.
APPROX. 25FT. LONG.
5
4
2
3
1b
APPLY WITH GASKET ON STEAM SIDE
1e
BLANK FLANGE
1/8" THICK
5 1/2" DIA. B.C.
4-11/16" HOLES.
5 1/2
5 1/2
8
7
6
9
10
FINAL DRAIN PLUG.
TURCO HYDRO STEAM UNIT OR EQUIVALENT
GROUND UNION JOINT
1a
1c
1d
11
APPROX. 25FT. LG.
5d
DISCHARGE LINE-CONNECT WITHOUT POCKETS TO PERMIT COMPLETE DRAINAGE.
SOLUTION TANK (100 GALLONS REQUIRED)
STRAINER
1d
3d
2d
4d
GAUGE MAINTAIN 50 P.S.I. APPROX.
REGULATING VALVE
DISCHARGE TO WASTE

| ITEM | QUAN | DESCRIPTION OF MATERIAL REQUIRED |
|---|---|---|
| 1 | 1 | TURCO UNIT OR EQUIVALENT - TURCO UNIT INCLUDES ALL (1) ITEMS. |
| 1a | 1 | SUCTION HOSE & STRAINER WITH CONNECTION FITTINGS |
| 1b | 1 | 3/4" HALF QUICK COUPLING FOR ATTACHING TO STEAM SUPPLY |
| 1c | 1 | 1/2" HALF QUICK COUPLING FOR ATTACHING TO HOSE END TO CONNECT TO HYDRO UNIT. |
| 1d | 2 | HOSE NIPPLES AND CLAMPS |
| 1e | 1 | 1/2" COMPLETE QUICK COUPLING FOR HOSE END AT COOLER |
|  |  | STEAM SUPPLY AND HOSE LINES |
| 2&2a | 2 | GAUGES FOR STEAM SUPPLY & DISCHARGE 0-100 P.S.I. |
| 3&3a | 2 | 3/4" TEE WITH 3/4" TO 1/4" REDUCER FOR GAUGE |
| 4&4a | 2 | VALVES 3/4" SIZE |
| 5&5a | 1 | 50 FT. MIN. LENGTH FLEX. STEAM HOSE (3/4" SIZE) CUT TO 25 FT. LENGTH OR TO SUIT. |
| 6 | 2 | 1" TO 1/2 I.P.S. REDUCING BUSHING (COOLER INLET & OUTLET) |
| 7 | 1 | 1/2" COMPLETE QUICK COUPLING (SAME AS 1e) |
| 8 | 2 | HOSE NIPPLES AND CLAMPS (SAME TYPE AS 1d) |
|  |  | MISCELLANEOUS |
| 9 | 1 | INLET FLANGE (REQUIRES 1/16" GASKET) |
| 10 | 1 | OUTLET FLANGE (REQUIRES 1/16" GASKET) |
| 11 | 1 | 1/4" VENT DISCHARGE LINE WITH VALVE. |
| 12 | 1 | LOT OF CLEANING MATERIAL. |

FIG. 1-3
CLEANING LUBRICATING OIL COOLER

6. After cleaning, flush cooler with water by filling solution tank and passing the water through the cooler with the steam aspirator. A faster flow rate may be used than with the cleaning solution.

7. Thoroughly drain after flushing, opening the 1/4" pipe tap in the lower shell flange. Pass steam through the cooler to thoroughly dry it.

8. Return all connections to original status, removing flange blanks, and replacing drain and vent plugs.

After removing the cleaning lines, inspect the tube surfaces to make sure that they are clean; they will not necessarily be bright, but should be free of deposits. Excessively dirty coolers, due to oil of improper characteristics or too long a time between cleaning periods, should receive special cleaning or be removed for vat cleaning. In order to maintain proper heat flow characteristics, and thus avoid excessively high oil temperatures, the cooler must be kept clean.

## INTERNAL LEAKS

If lubricating oil should appear in the sight glass of the expansion tank or water in the lubricating oil, the following check should be made on the cooler:

1. Drain shell side of oil through the pipe tap in the bottom shell flange. Leave this drain open.

2. Drain water system, blank off water inlet and outlet connections. Fill cooler full of water.

3. Apply air or water pressure not to exceed 50 psi at the pipe located in the bottom end cover.

4. Should any leakage exist, water will presently appear at the drain left open as noted above.

5. If leakage occurs, cooler must be removed to the shop for dismantling to locate tube failure. By applying pressure similarly at the oil side, tube leakage can be observed by removing end covers.

## TUBE AND SHELL CAPACITIES

| | |
|---|---|
| Tube capacity (water) | 11 gallons |
| Shell capacity (oil) | 16 gallons |

## STRAINER

The strainer is of the basket type with oil entering the bottom and flowing up through a spool containing a series of staggered holes. From the spool, oil dumps into a fine brass mesh screen enclosed by a steel perforated shell.

## CLEANING

The strainer element should be cleaned at each filter change or more often as necessary. In cleaning the element never use steam or a strong cleaning solution. The following cleaning method is recommended using two alternate compounds, Turco Products or Oakite Products.

### TURCO MULSIREX

Mix one (1) part of Mulsirex with eight (8) parts of distillate in a cold immersion tank. Agitate with air for 20 to 30 minutes, remove, drain and immerse in a tank of clean distillate. Carefully rinse with a spray of air and kerosene making sure this operation is not performed at close range as high pressure rinsing may result in damage to the wire mesh screening in the strainer.

### OAKITE COMPOSITION NO. 9

Mix one (1) part of Oakite #9 with four (4) parts of kerosene in a cold immersion tank. Allow strainer to soak for 30 minutes, remove and carefully rinse with a spray of air and kerosene. The rinsing operation should not be performed at close range as high pressure rinsing may result in damage to the wire mesh screening in the strainer.

## LOW OIL PRESSURE SWITCHES

Each Diesel engine is protected from low lubricating oil pressure by two switches. The first switch OPS 1 is set for 20 psi and returns the engine to idle when the throttle is in the fifth, sixth, seventh or eighth notch, while the second switch, OPS 2, set for 7 psi, will shut the engine down in all throttle positions. If the lubricating oil pressure should drop below 20 psi and remain above 7 psi the engine may be operated at partial load by returning the engine control knob on the engine control panel to No. 4 position.

On freight and passenger locomotives these switches are located in the left section of the engine control panel while on the road switchers they are located in the engine compartment on the left side of the rear bulkhead.

The switch cover is easily removed by loosening the knurled knob at the front of the case which after its removal will expose the internal working parts of the switch.

However, it is not necessary to remove the cover when making pressure adjustments as each adjustment is made by means of external adjusting screws equipped with an indicator and calibrated scale clearly visible through a window in the cover.

Two pressure adjustments are made, the range and differential. The adjusting screws are located on top of the case, the left one for range adjustment, the right one for differential.

The range or cut-in pressure is raised by turning the left adjusting screw to the right and lowered by turning to the left. The differential pressure, that is the difference between the cut-in and cut-out pressure, is increased by turning the right adjusting screw to the right or decreased by turning to the left.

Both pressure switches should be checked monthly to insure against maladjustment resulting from vibration or any other cause.

## LUBRICATING PROBLEMS

### A. DILUTION

Water - Discoloration of the lubricating oil to a gray brown color is evidence of water in the oil. Any thickening or emulsifying of the oil is more evidence of water. Possible sources of water in the oil may be traced back to a defective water seal in the water pump with the tell-tale hole plugged, cracked liner or cylinder head, defective liner or water jacket seal rings or damaged tubes in the lubricating oil cooler. Never operate an engine if the presence of water in the oil is detected.

Fuel Oil - The presence of fuel oil in the lubricating oil can be detected by a gradual rise in the lubricating oil level during operation, unable to maintain normal oil pressure or by a definite fuel oil odor in the lubricating oil. Possible sources of fuel oil in the lubricating oil may be traced back to a defective nozzle and its connecting piping. Never operate an engine when the percentage of fuel dilution reaches or exceeds 5%.

### B. LOW LUBRICATING OIL PRESSURE

This may be caused by a broken oil line, inoperative pressure regulating valve, clogged filters, defective pump, hot engine or diluted or low viscosity oil.

### C. EXCESSIVE OIL CONSUMPTION

This may be caused by an oil leak; worn, broken or stuck piston rings; broken, stuck or clogged oil control rings; clogged drain holes in pistons or an improper grade of oil.

### D. LITTLE OR NO OIL CONSUMPTION

This may be caused by water or fuel oil leaking into the oil, improper oil control rings or too heavy an oil.

## LUBRICATING OIL SPECIFICATIONS

Only high quality additive type heavy duty lubricating oil of SAE 40 viscosity characteristics having passed the Alco 500 hour engine approval test shall be used in the crankcase of these engines.

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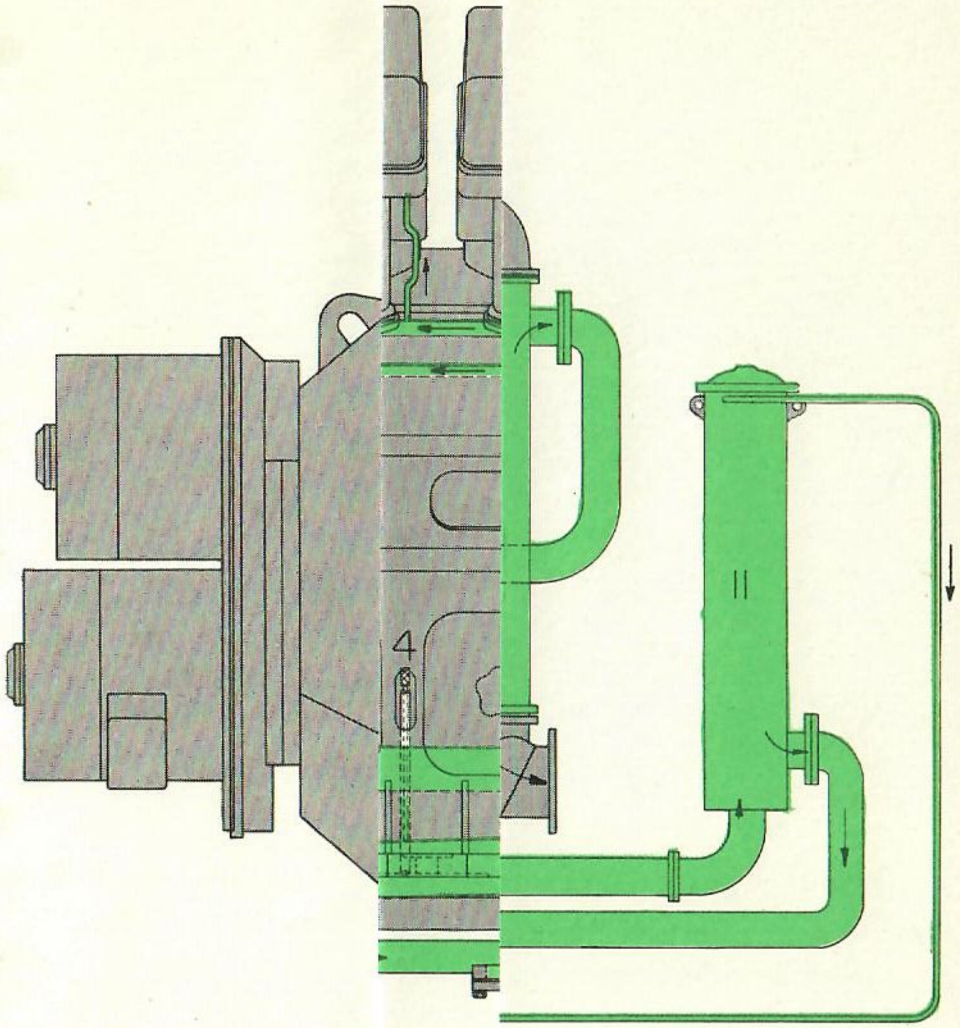
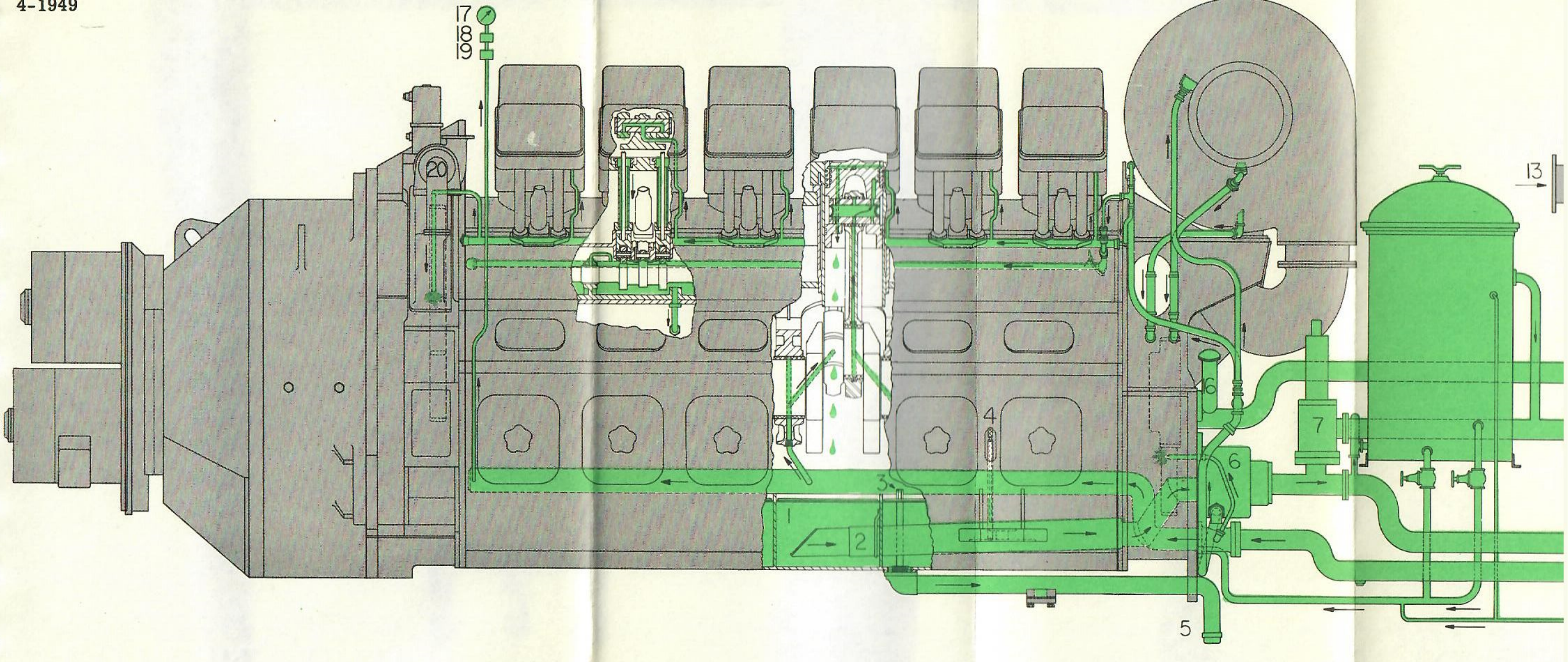


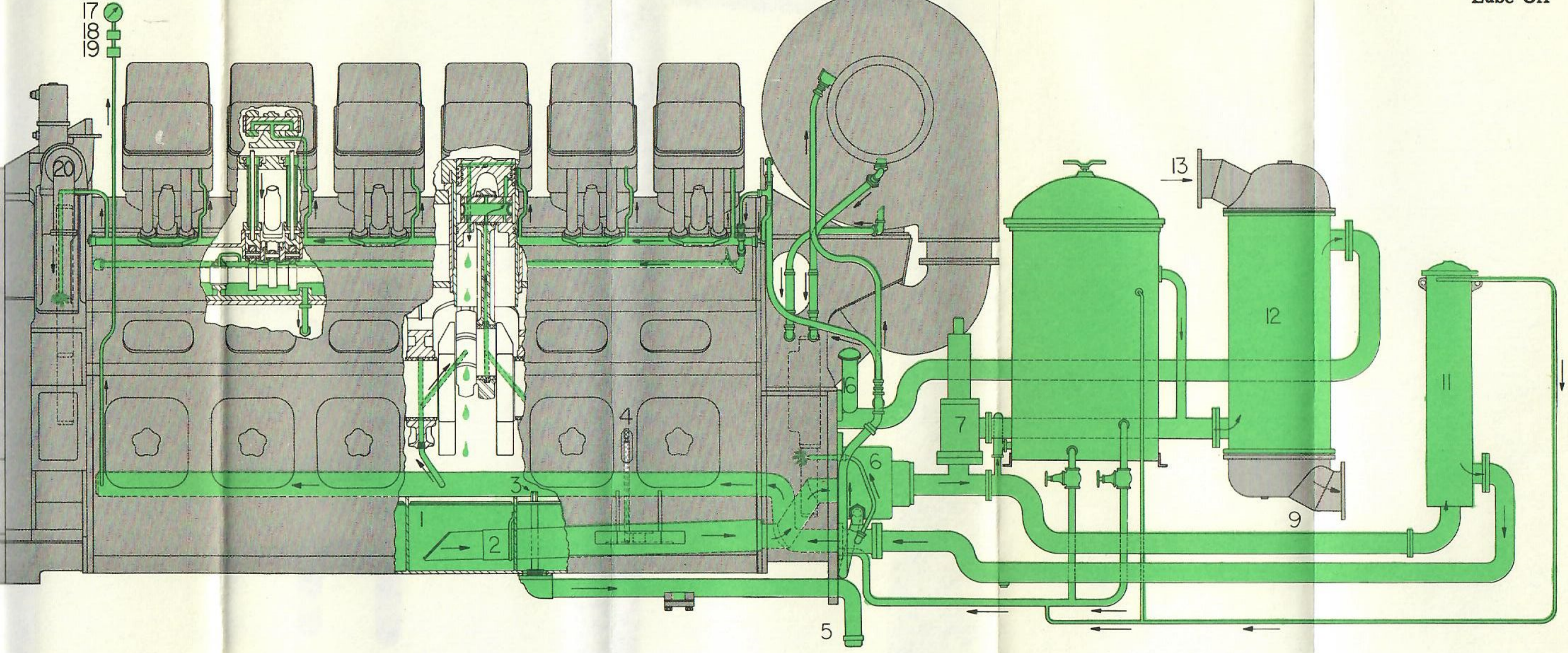
1. Lainer p
2. Poler
3. Boler
4. B Handle
5. Dter

FIG. 2-3
BRICATING OIL SYSTEM

TP-400
4-1949



1. Lube Oil Sump
2. Pump Suction Pipe
3. Base Drain Plug
4. Bayonet Gauge
5. Drain Pipe and Cap
6. Lube Oil Pump
7. Pressure Regulating Valve
8. Filter Drain Valves
9. Water from Cooler
10. Strainer Drain Valve
11. Lube Oil Strainer
12. Lube Oil Cooler
13. Water to Cooler
14. Filter Cover Handle and Priming Connection
15. Lube Oil Filter
16. Lube Oil Filler Pi
17. High Pressure Ga
18. Oil Pressure Switc
19. Oil Pressure Switc
20. Crankcase Exhaus



6. Lube Oil Pump
7. Pressure Regulating Valve
8. Filter Drain Valves
9. Water from Cooler
10. Strainer Drain Valve
11. Lube Oil Strainer
12. Lube Oil Cooler
13. Water to Cooler
14. Filter Cover Handle and Priming Connection
15. Lube Oil Filter
16. Lube Oil Filler Pipe with Cap
17. High Pressure Gauge
18. Oil Pressure Switch 1
19. Oil Pressure Switch 2
20. Crankcase Exhauster

FIG. 2-3
LUBRICATING OIL SYSTEM

# COOLING WATER SYSTEM

## DESCRIPTION

The engine in each locomotive unit has an individual cooling water system, Fig. 9-4. The cooling water, circulated by a pump, flows to right and left bank headers which are connected to the water jackets by individual jumpers.

Water then flows through the space formed by the liner and jacket, enters the cylinder heads and out through elbows which are connected to water outlet headers. Water then flows to the radiators, cab heaters and expansion tank. Cooled water from the radiators flows through the oil cooler and finally to the water pump. It is a closed system with the expansion tank vented to atmosphere through an overflow pipe.

Water temperature of 140° - 160° is maintained by thermostatically controlled shutters and fan.

## FILLING THE SYSTEM

The system may be either filled under a maximum pressure of 25 psi by connecting a hose to the filler nozzle and opening the filler-drain valve, or by gravity through a roof filling connection into the expansion tank. The inlet and outlet valves at the cab heaters should be open when filling the system.

## WATER LEVEL

The water expansion tank is located at the highest point in the cooling water system and is equipped with a sight level glass and overflow pipe. Never operate the engine without water showing in the sight glass.

## WATER TREATMENT

Water treatment compound must be used at all times to maintain the Diesel engine cooling system in proper condition and prevent corrosion. Do not use a boiler water treatment compound or oil in the engine water. Where anti-freeze compounds are used, special instructions will have to apply, and materials shown herein should not be used. Treatment compounds or cleaners that will attack the rubber hose connections, cylinder head gaskets or that might corrode fitted joints must not be used.

It is recommended that the following quantities of either Dearborn 517 or Nalco 38, which are powder treatments, be added to maintain ph value of 8.5 minimum and chromate concentration of 2000 parts per million minimum at all times.

1. Alco 9 x 10-1/2 Road Switcher, cooling system capacity 250 gallons, including 60 gallon expansion tank.
    (a) 7-1/2 pounds of Dearborn 517 or Nalco 38 required for each complete filling of the cooling system and 1/2 ounce for each gallon of water added thereafter.
2. Alco 9 x 10-1/2 Road Freight Locomotives (A and B units), cooling system capacity 280 gallons, including 90 gallon expansion tank.
    (a) 9 pounds of Dearborn 517 or Nalco 38 required for each complete filling of cooling system and 1/2 ounce for each gallon added thereafter.
3. Alco 9 x 10-1/2 Passenger Locomotives (A and B units), cooling system capacity 330 gallons, including 90 gallon expansion tank.
    (a) 10 pounds of Dearborn 517 or Nalco 38 required for each complete filling of cooling system and 1/2 ounce for each gallon added thereafter.

Only clean water must be used in the cooling system. Examine engine interior at time of overhaul to determine that correct treatment has been followed. Treatment

compounds should not be allowed in contact with body. When treatment is used, it is not necessary to flush the system except for unusual causes.

## OIL IN SYSTEM

In case oil is ever noticed in the water glass, which indicates oil in the water system, eliminate the source, flush the system, refill and add 10 pounds of tri-sodium phosphate. The engine should be operated with this solution in the system, for one day only, then drain and flush. Refill the system with fresh water and add the correct amount of water treatment.

## DRAINING THE SYSTEM

Open the filler-drain valve and the inlet and outlet valves at the cab heaters. By opening these valves, water will drain from the expansion tank, radiators, oil cooler, cab heaters and all of the Diesel engine except the lower portion of the volute casing of the water pump. Remove the pipe plug in the bottom of this casing to completely drain the water pump and open cab heater vent valves.

## FREEZING WEATHER PRECAUTIONS

The use of anti-freeze is not recommended because of the use of water treatment in the system and the fact that anti-freeze will not prevent the lubricating oil from congealing when the engine is shut down.

When a locomotive is so equipped, use the steam train line and open steam supply valve to water system to prevent freezing, otherwise connect a steam line to the fill-nozzle using 4 or 5 pounds pressure.

Check the amount of water treatment in the water after heating the system with steam and add the necessary amount of treatment to replace the loss.

If no steam is available, either idle the engine or drain the water system.

## HIGH WATER TEMPERATURE SWITCH

A thermal sensitive element is installed in the left bank water outlet manifold between the engine and radiator. If the water temperature at this point reaches 185°, a high water temperature switch located below the fan control will operate. The hot engine indicating light will light, alarm bells will ring, a buzzer will sound in the cab and the engine in the unit affected will return to idle.

Two adjustments are made on the switch, the range and differential. The adjusting screws are located on top of the case, the left one for the range adjustment, the right one for the differential adjustment.

The range, or cut-in temperature, is raised by turning the left adjusting screw to the right, or lowered by turning it to the left. The differential temperature, that is, the difference between the cut-in and cut-out temperature, is increased by turning the right adjusting screw to the right or decreased by turning it to the left. Each adjusting screw is equipped with an indicator and calibrated scale clearly visible through the window in the cover.

## TEMPERATURE CONTROL -- MINNEAPOLIS-HONEYWELL

There are two types of temperature control in service, namely, the General Electric and the Minneapolis-Honeywell. For the description of the General Electric equipment, refer to the index.

## DESCRIPTION Fig. 1-4

Air for the operation of the engine water temperature control is supplied from the 70 lb. control air reservoir through a cut-out valve and filter. The filtered air is then reduced from 70 psi to 17 psi by a reducing valve. A relief valve, set at 19 psi, is located in the low pressure line which connects the reducing valve with the Grad-U-Stat. From the Grad-U-Stat a branch line extends to a small reservoir, the pressure in which will vary as the temperature rises or falls. This Grad-U-Stat is reverse acting, that is, when the temperature rises the pressure in the reservoir falls.

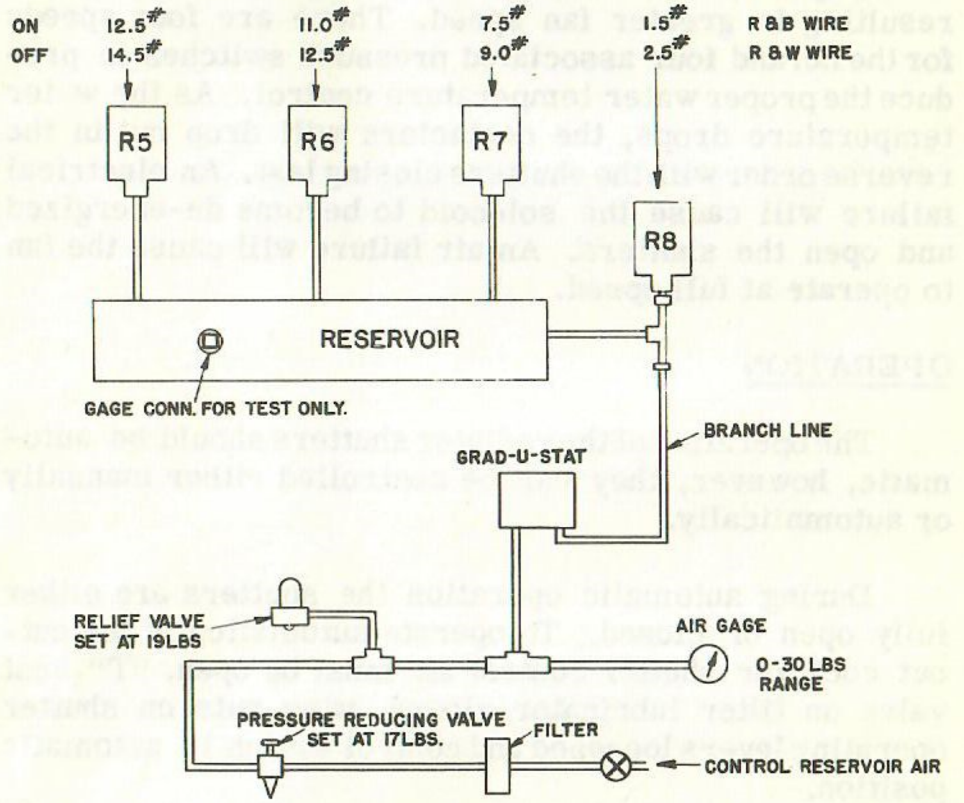


FIG. 1-4
PNEUMATIC ELECTRIC RELAYS SETTINGS

The reservoir is connected to four pneumatic-electric relays or pressure switches. Each switch represents a particular speed of the fan, from low to high speed, each having a different setting, - namely: 12-1/2 lbs., 11 lbs., 7-1/2 lbs., and 1-1/2 lbs. As the temperature rises, the Grad-U-Stat causes the pressure in the reservoir to drop. When it reaches 12-1/2 lbs. the first switch closes, de-energizing the solenoid valve in the shutter operating air system, thus opening the shutters. Each switch is connected electrically to one of four contactors. The contactor, R1, which is associated with the 12-1/2 lb. switch, R5, introduces a 34 ohm resistance and connects power to the Eddy Current Clutch Field which starts the fan at low speed. If the temperature continues to rise causing a further drop in reservoir pressure, the 2nd or 11 lb. switch closes, which in turn brings in the 2nd contactor, lowering the resistance in the Eddy Current Clutch Field, resulting in greater fan speed. There are four speeds for the fan and four associated pressure switches to produce the proper water temperature control. As the water temperature drops, the contactors will drop out in the reverse order with the shutters closing last. An electrical failure will cause the solenoid to become de-energized and open the shutters. An air failure will cause the fan to operate at full speed.

## OPERATION

The operation of the radiator shutters should be automatic, however, they can be controlled either manually or automatically.

During automatic operation the shutters are either fully open or closed. To operate automatically the cutout cock for shutter control air must be open, "T" vent valve on filter lubricator closed, wing nuts on shutter operating levers loosened and control switch in automatic position.

During manual operation, any desired shutter setting may be obtained, each shutter being individually operated. To operate manually, close the cutout cock for shutter control air and open "T" vent valve. Move shutter operating levers to maintain 140° F to 160° F temperature and lock in place with wing nuts. If water temperature is not properly maintained by this method, lock both shutter operating levers in full open position and then manually select fan speed to maintain temperature.

The radiator fan speed is automatically controlled, however, a manual selection can be made of any of the four fan speeds. For automatic operation move the radiator fan control switch to AUTOMATIC position. Fig. 2-4. For manual operation, move this switch to positions OFF-1 - 2 - 3 or 4, to maintain 140° F to 160° F temperature.

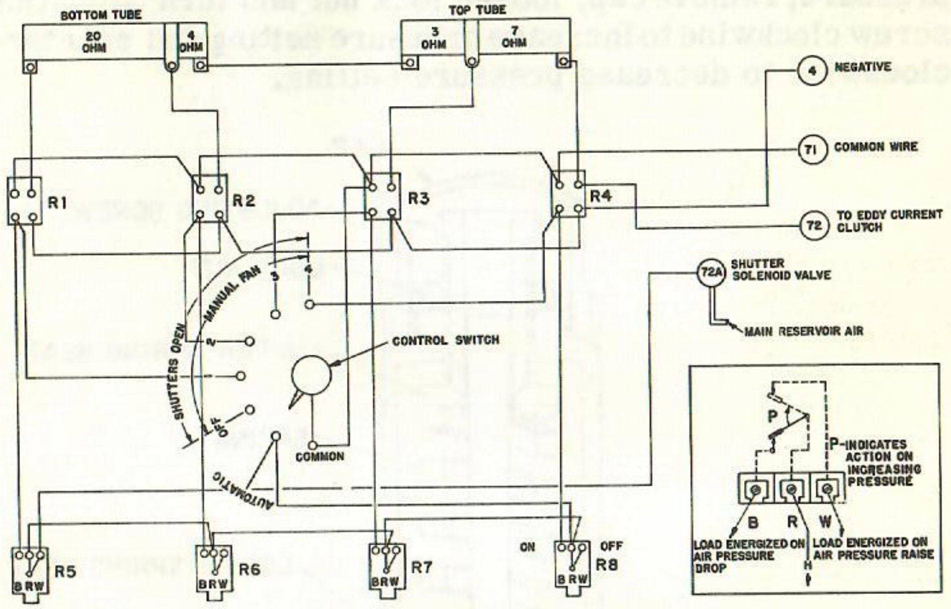

BOTTOM TUBE
20 OHM
4 OHM
TOP TUBE
3 OHM
7 OHM
4 NEGATIVE
71 COMMON WIRE
72 TO EDDY CURRENT CLUTCH
72A SHUTTER SOLENOID VALVE
MAIN RESERVOIR AIR
R1
R2
R3
R4
MANUAL FAN
3
4
2
SHUTTERS OPEN
OFF
CONTROL SWITCH
COMMON
AUTOMATIC
ON
OFF
R5
R6
R7
R8
BRW
P
P-INDICATES ACTION ON INCREASING PRESSURE
B
R
W
LOAD ENERGIZED ON AIR PRESSURE DROP
LOAD ENERGIZED ON AIR PRESSURE RAISE

FIG. 2-4
WIRING DIAGRAM
EDDY CURRENT CLUTCH CONTROL

**High water temperature alarm set at 185° F will ring the alarm bell, light the hot engine lights on all units and return the unit affected to idle speed.**

## MAINTENANCE

### Reducing Valve

This valve must be set to maintain 17 psi. A lower setting will cause the fan to operate continuously.

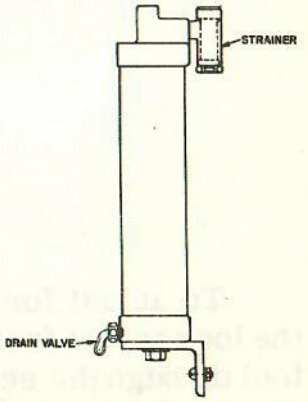

STRAINER
DRAIN VALVE

FIG. 3-4
FILTER

### Filter Fig. 3-4

Blow down weekly, or more often if necessary, by opening drain valve. Remove strainer assembly and clean monthly.

**Relief Valve** Fig. 4-4

Set at 19 psi with 1 to 2 lb. blowdown. To adjust pressure, remove cap, loosen lock nut and turn adjusting screw clockwise to increase pressure setting and counterclockwise to decrease pressure setting.

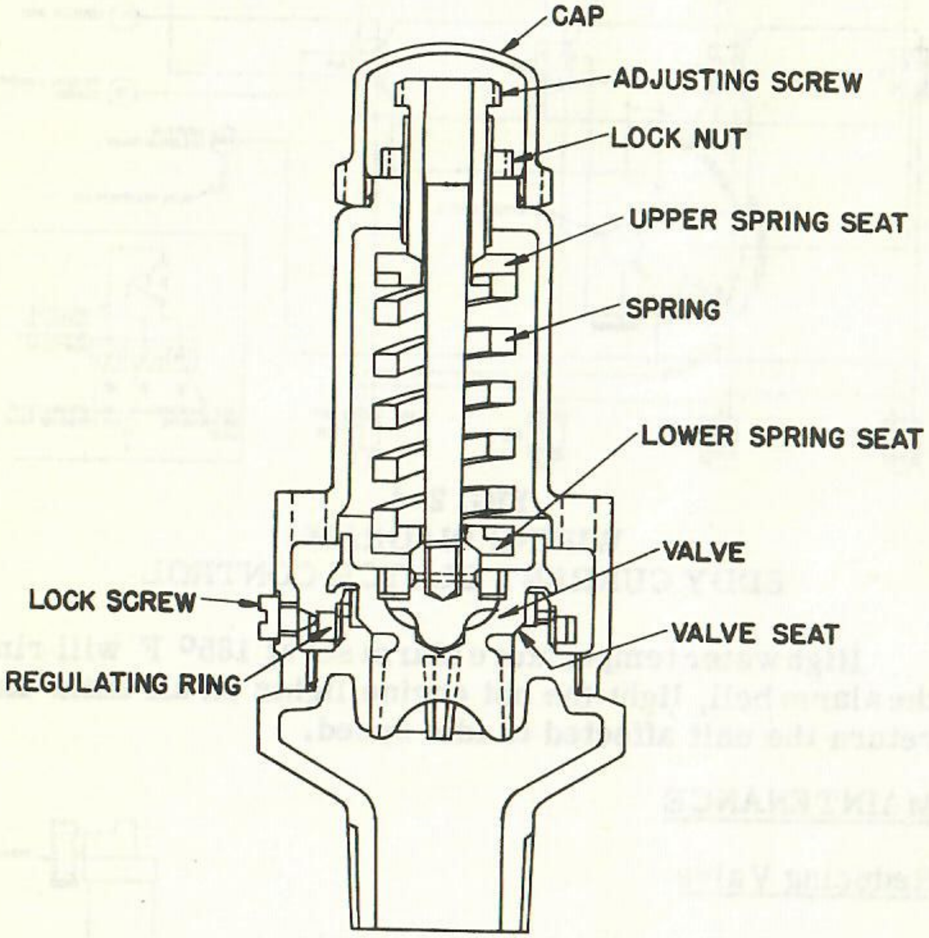

CAP
ADJUSTING SCREW
LOCK NUT
UPPER SPRING SEAT
SPRING
LOWER SPRING SEAT
VALVE
VALVE SEAT
LOCK SCREW
REGULATING RING

FIG. 4-4
RELIEF VALVE

To adjust for one pound blowdown pressure, remove the lock screw from the side of the valve. Insert a small tool through the screw hole to engage the grooved edge of the regulating ring. Turn the ring clockwise to decrease blowdown and counterclockwise to increase blowdown. When setting is completed, replace the screw and test.

**GRAD-U-STAT** Fig. 5-4

**Operation**

This device, governed by the cooling water temperature out of the radiator, varies the air pressure to a series of relays.

The sensitive capsule (20) is affected by the temperature of the cooling water and creates a pressure in the bellows (7) which is partially balanced by the main spring (5). Adjusting screw (1) is set to maintain the desired control point.

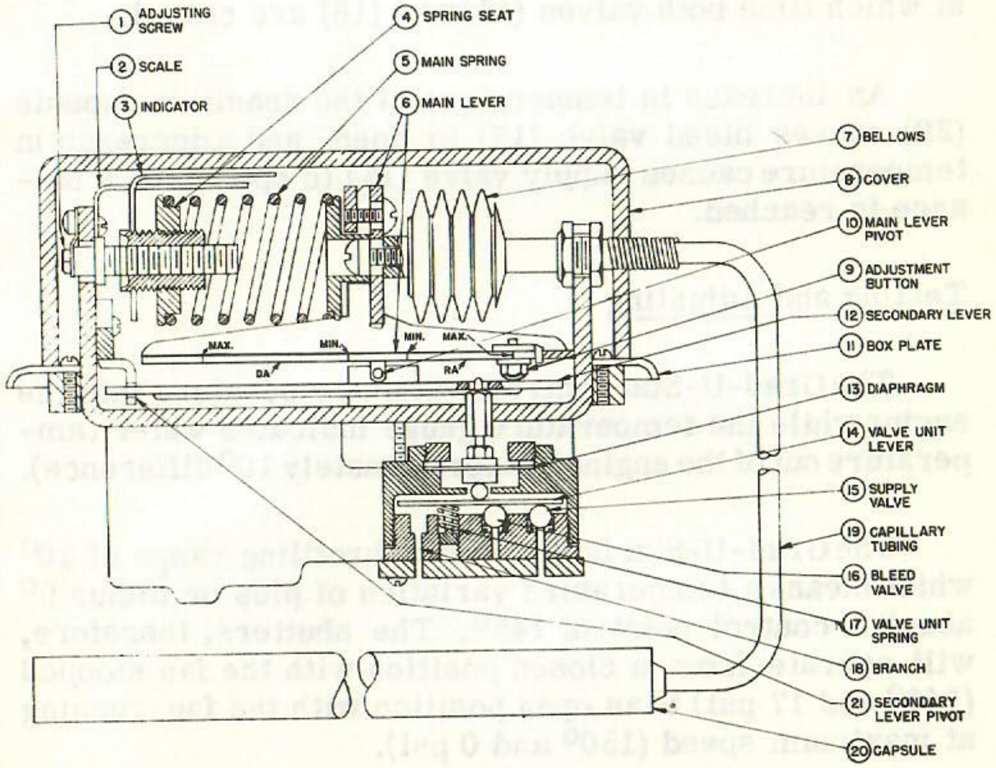

① ADJUSTING SCREW
② SCALE
③ INDICATOR
④ SPRING SEAT
⑤ MAIN SPRING
⑥ MAIN LEVER
⑦ BELLOWS
⑧ COVER
⑩ MAIN LEVER PIVOT
⑨ ADJUSTMENT BUTTON
⑫ SECONDARY LEVER
⑪ BOX PLATE
⑬ DIAPHRAGM
⑭ VALVE UNIT LEVER
⑮ SUPPLY VALVE
⑲ CAPILLARY TUBING
⑯ BLEED VALVE
⑰ VALVE UNIT SPRING
⑱ BRANCH
㉑ SECONDARY LEVER PIVOT
⑳ CAPSULE
MAX.
MIN.
MIN.
MAX.
DA
RA

FIG. 5-4
GRAD-U-STAT

Main lever (6) is hinged at pivot (10) and operates secondary lever (12) through the adjustment button (9). The secondary lever (12) is hinged at pivot (21) and rests on diaphragm (13).

The chamber beneath diaphragm (13) is open to the branch line leading to the controlled device, and this branch line pressure causes diaphragm (13) to balance whatever excess pressure may exist in the bellows (7) over main spring (5).

If the system is in balance and there is a temperature change at the sensitive capsule (20), levers (6) and (12) will move diaphragm (13) and the valve lever (14) so as to admit air from the main at 17 pounds pressure through supply valve (15) to the branch line or to bleed air from the branch line through bleed valve (16) until the change in pressure under diaphragm (13) balances the effect of the temperature change on capsule (20), and bellows (7), at which time both valves (15) and (16) are closed.

An increase in temperature at the sensitive capsule (20) causes bleed valve (16) to open, and a decrease in temperature causes supply valve (15) to open until a balance is reached.

## Testing and Adjusting

The Grad-U-Stat controls water temperature into the engine while the temperature gauge indicates water temperature out of the engine. (Approximately 10° difference).

The Grad-U-Stat is set with a throttling range of 10° which means a temperature variation of plus or minus 5° about a control point of 145°. The shutters, therefore, will operate from a closed position with the fan stopped (140° and 17 psi) to an open position with the fan running at maximum speed (150° and 0 psi).

The Grad-U-Stat is equipped with a main lever (6) on which is mounted an adjustment button (9). The lever is marked with a minimum and maximum point on both sides of the main lever pivot. The adjustment button should be located on the right side of the main lever pivot below the bellows. In order to adjust for a 10° throttling range, the adjustment button should be moved so that its centerline passes through the maximum mark on the reverse acting (RA) side of the main lever. The throttling range is decreased by moving the adjustment button towards the minimum mark and increased by moving it towards the maximum mark.

To obtain the control point of 145°, remove the plug from the branch line reservoir and insert an accurate gauge (0 - 30 lbs.). Remove the capsule from the radiator water outlet pipe and place in a container of water heated to 145° F. At this temperature, the gauge should show 7-1/2 lbs.; if not, turn the adjusting screw (1) until 7-1/2 lbs. is obtained.

There are two methods by which the control point can be changed:

1. Apply accurate pressure gauge (0 - 30 lbs.) to branch line reservoir. Remove capsule from radiator water outlet pipe and place in a container of water heated to the desired control point temperature. Turn adjusting screw (1) until 7-1/2 lbs. is registered on gauge.

2. The Grad-U-Stat is equipped with an indicator, the scale of which is marked with a high and low point. The range from the low to the high point is 30° (145° - 175°) and the scale is marked in increments of 5°. To raise the control point temperature, turn the adjusting screw (1), so that the indicator will move toward the high mark. To lower the control point temperature, turn the adjusting screw so that the indicator will move toward the low mark.

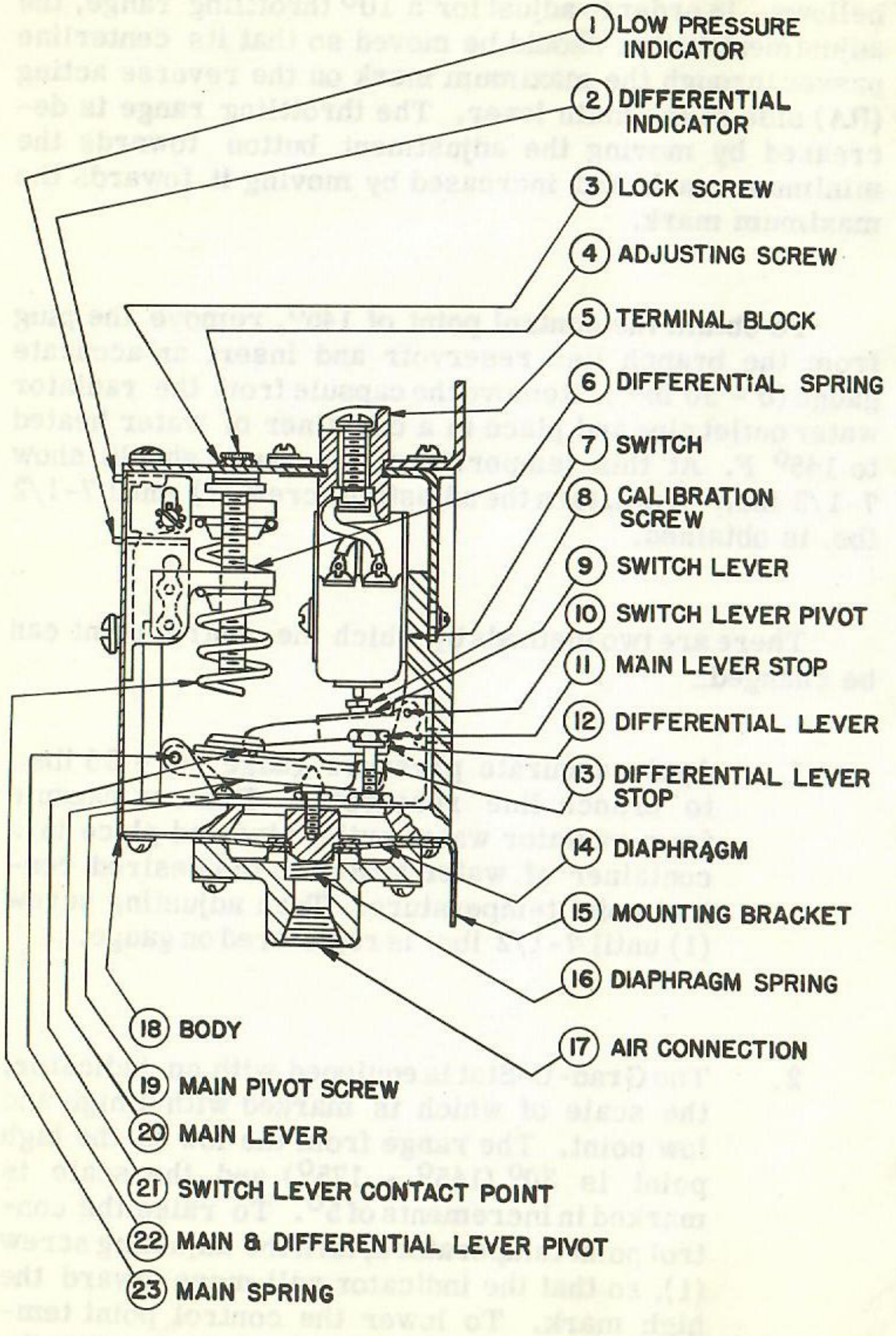

1 LOW PRESSURE INDICATOR
2 DIFFERENTIAL INDICATOR
3 LOCK SCREW
4 ADJUSTING SCREW
5 TERMINAL BLOCK
6 DIFFERENTIAL SPRING
7 SWITCH
8 CALIBRATION SCREW
9 SWITCH LEVER
10 SWITCH LEVER PIVOT
11 MAIN LEVER STOP
12 DIFFERENTIAL LEVER
13 DIFFERENTIAL LEVER STOP
14 DIAPHRAGM
15 MOUNTING BRACKET
16 DIAPHRAGM SPRING
17 AIR CONNECTION
18 BODY
19 MAIN PIVOT SCREW
20 MAIN LEVER
21 SWITCH LEVER CONTACT POINT
22 MAIN & DIFFERENTIAL LEVER PIVOT
23 MAIN SPRING

FIG. 6-4
PNEUMATIC ELECTRIC RELAY

## PNEUMATIC-ELECTRIC RELAY Fig. 6-4 & 7-4

### Operation

The Pneumatic-Electric Relay is a snap acting single pole double throw relay, designed to convert gradual air pressure changes into positive electrical switching action.

On an increase in air pressure, the force exerted by the diaphragm (14) is increased. This increased force is transmitted through the main pivot screw (19) to the main lever (20), and is opposed by the main spring (23).

When the force exerted by the diaphragm is sufficient to overcome that exerted by the main spring, the main lever (20) will start rotating counterclockwise about its pivots (22). The switch lever (9), pivoting at the switch lever pivot (10), will then start rotating clockwise, since it rides on the main lever at the switch lever contact point (21). The plunger of the switch (7) is thus started in motion since it contacts the calibration screw (8) which is attached to the switch lever.

Before the main lever has moved far enough to cause the switch to snap over, it contacts an ear at the end of the differential lever (12). This lever is loaded by the differential spring (6), and when it is picked up by the main lever, the force exerted by the diaphragm must be increased through increased air pressure. When the diaphragm force overcomes the forces of both springs, the main lever can continue its counterclockwise rotation, and cause the switch to snap over through the remaining leverage system.

After a slight over travel, the main lever comes up against the main lever stop (11). This takes any excess load exerted by the diaphragm and thus prevents damage to the switch.

On a decrease in air pressure, the force exerted by the diaphragm decreases. Thus the main and differential springs exert the greater force on the leverage system, and the main and differential levers begin rotating clockwise, thus allowing the switch plunger to move down. Before the plunger moves far enough to permit the switch to snap over, the differential lever is stopped by the differential lever stop (13). The air pressure under the diaphragm must then decrease still further so the main spring alone can overcome the diaphragm force and force the main lever to travel far enough to allow the switch to snap over.

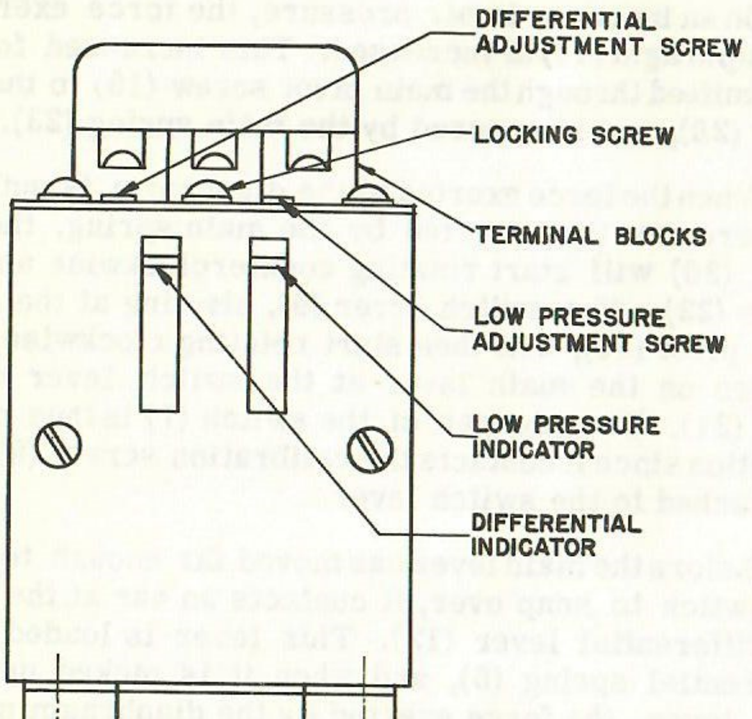


FIG. 7-4
PNEUMATIC ELECTRIC RELAY

The forces exerted by the main and the differential springs can be adjusted by means of the adjusting screws (4) on the top of the case, and locked at the desired points by tightening the lock screw (3) located between the adjusting screws.

The diaphragm spring (16) provides slightly more than enough force under the diaphragm at all times to throw the switch. Hence, the main spring must always be at least slightly compressed.

---

## Testing and Adjusting

With the engine cool, maximum pressure of 17 pounds should be indicated on the gauge showing reservoir pressure. The low pressure setting of the relay is that at which the switch snaps over as the pressure is reduced. The high pressure setting is that at which the switch snaps over as the pressure increases and this setting is made by turning the differential adjustment screw. The differential scale on the front of the instrument indicates pounds pressure above the low pressure setting. Scales indicate approximate settings.

### To set the operating pressures:

1. Mount an accurate pressure gauge (0-30 lbs.) in the gauge connection on the reservoir, Fig. 1-4. Use a voltmeter across R and B to determine switch action. Gradually decrease the air pressure on the relay from 17 lbs. noting the pressure at which the switch snaps (low pressure setting R and B connected - switch on).

2. Loosen locking screw, Fig. 7-4, and turn the low pressure setting screw in the direction to approach the desired low pressure setting. Increase air pressure and then reduce again to check setting as in 1.

3. Repeat, if necessary, to get correct low pressure setting.

4. Increase the air pressure gradually from zero, noting pressure at which the switch snaps (high pressure setting - R and B broken - switch off). Turn the differential adjustment screw to approach the desired setting, (differential, pounds above the low pressure setting). Reduce the pressure below the low pressure setting and again increase it gradually until the switch snaps.

5. Repeat, if necessary, to get correct high pressure setting and firmly tighten locking screw.

6. Check the wiring to be sure the proper switching action is obtained.

## TROUBLE SHOOTING

1. Check air pressure to assure 17 psi supply to Grad-U-Stat.
2. Blow down air filter to remove water and sediment.
3. Check Grad-U-Stat settings - - adjustment button should be on the RA side at the maximum position.
4. Make sure good electrical contact is obtained on relays R-1, R-2, R-3 and R-4. Make sure no foreign substance is lodged behind contact arm preventing complete closure. Contact gap measured at the rear edge of the contacts should be 5/32" to 3/16". Adjustment is made by loosening jam nut and screwing contact button in the desired direction. Jam nut should be retightened after adjustment. The wipe on the contacts should be 1/32" approximately, measured at the edge of the bakelite under the center of the contact fingers.
5. With accurate pressure gauge, check pneumatic-electric relays (R-5, R-6, R-7, R-8) for proper pressure settings and switch actions.

## WATER PUMP

A centrifugal water pump, Fig. 8-4, is mounted on the free end casing and driven from the engine crankshaft through a spline drive.

Before applying a pump, pour approximately one pint of lubricating oil into the oil hole on top of the pump which leads to the chamber between the two ball bearings. This will assure oil seal and bearing lubrication until the normal flow of lubricating oil reaches these parts from the gear train spray.

In mounting a pump to the engine no precautionary measures are required as a boss on the back of the pump assembly assures positive alignment.

A tell-tale hole is provided to indicate a defective oil or water seal. A few drops of water out of this hole is normal. Seals should be renewed when there is any oil

leakage or excessive amount of water leakage. Never plug the tell-tale hole.

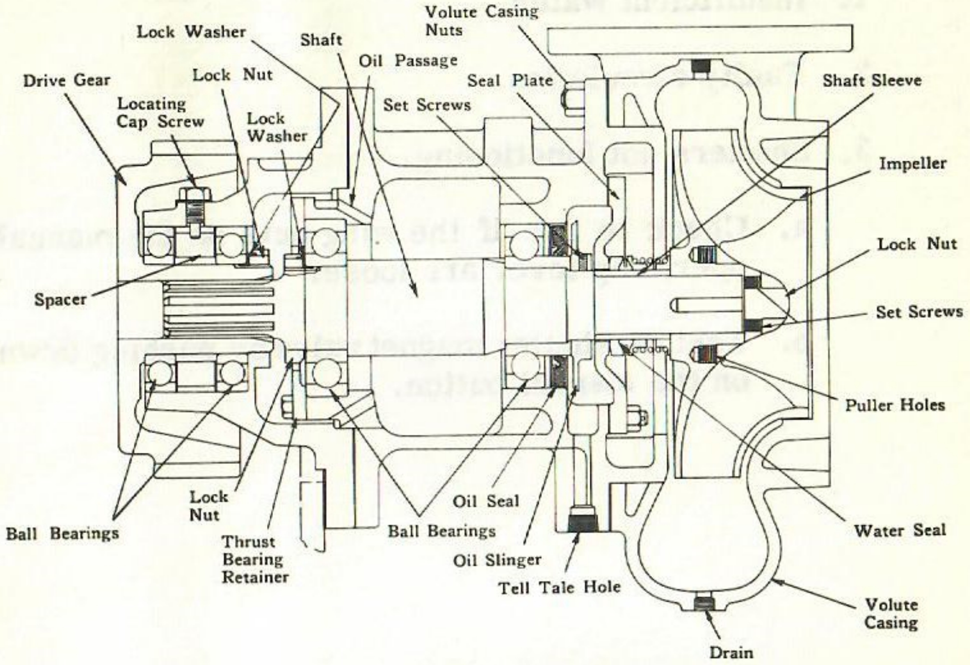

Volute Casing Nuts
Lock Washer
Shaft
Oil Passage
Drive Gear
Lock Nut
Seal Plate
Shaft Sleeve
Locating Cap Screw
Lock Washer
Set Screws
Impeller
Lock Nut
Spacer
Set Screws
Puller Holes
Lock Nut
Oil Seal
Ball Bearings
Thrust Bearing Retainer
Ball Bearings
Oil Slinger
Water Seal
Tell Tale Hole
Volute Casing
Drain

FIG. 8-4
WATER PUMP

## CAB HEATERS

The cab heaters are supplied with hot water from the outlet header of the Diesel engine. The speed of the fan is varied by a control switch. Inlet and outlet water valves are provided to shut off the flow of water through the heaters. By opening a vent valve, located on top of each heater, air pockets may be eliminated which otherwise would prevent proper circulation through the heaters.

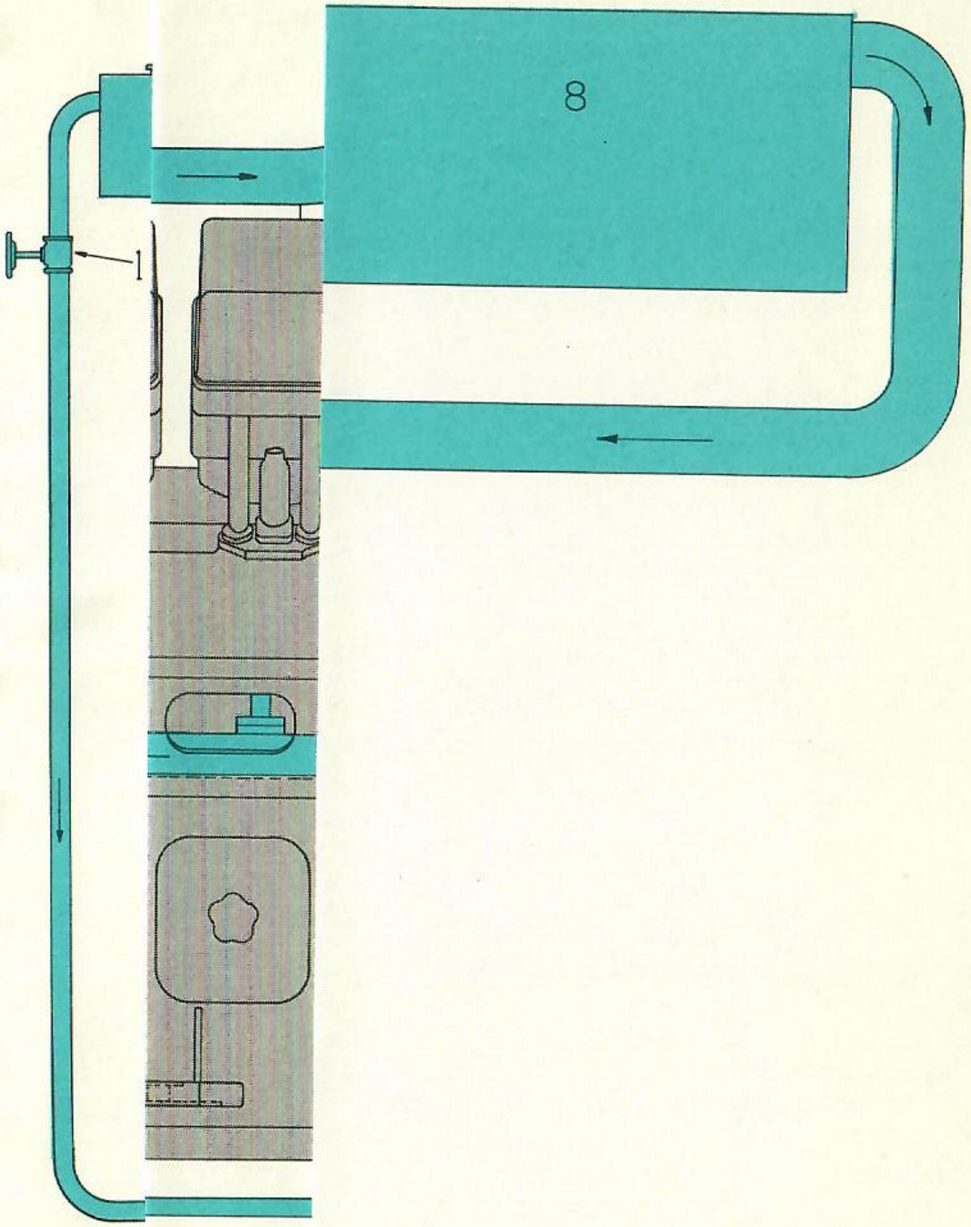
## COOLING PROBLEMS

A. If oil should appear in the cooling water:

1. Tubes in lubricating oil cooler defective.
2. Cylinder liner cracked. This will also cause a continuous spurting of water out of the expansion tank overflow pipe.

**B.** If the high water temperature alarm rings:

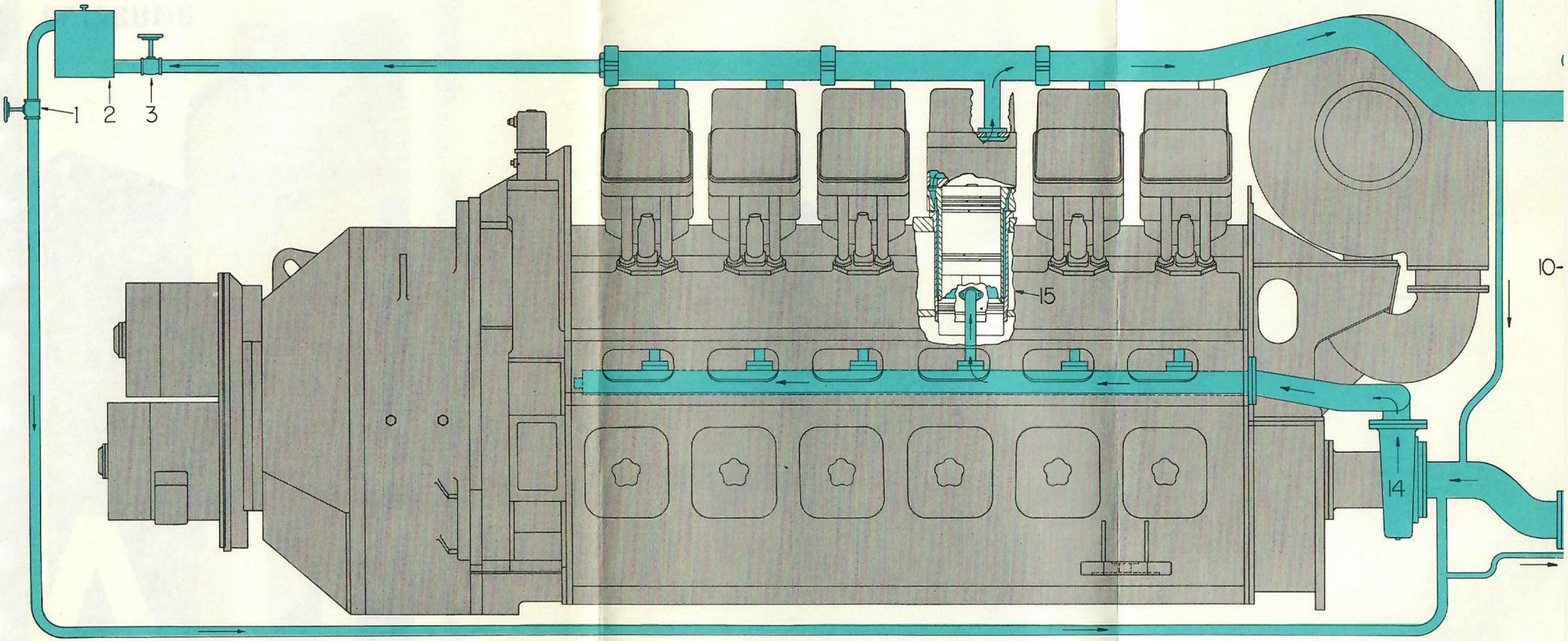
1. Insufficient water.
2. Faulty circulation.
3. Shutters not functioning.
    - a. Check to see if the wing nuts on the manual operating lever are loose.
    - b. Test the shutter magnet valve by pushing down on the manual button.



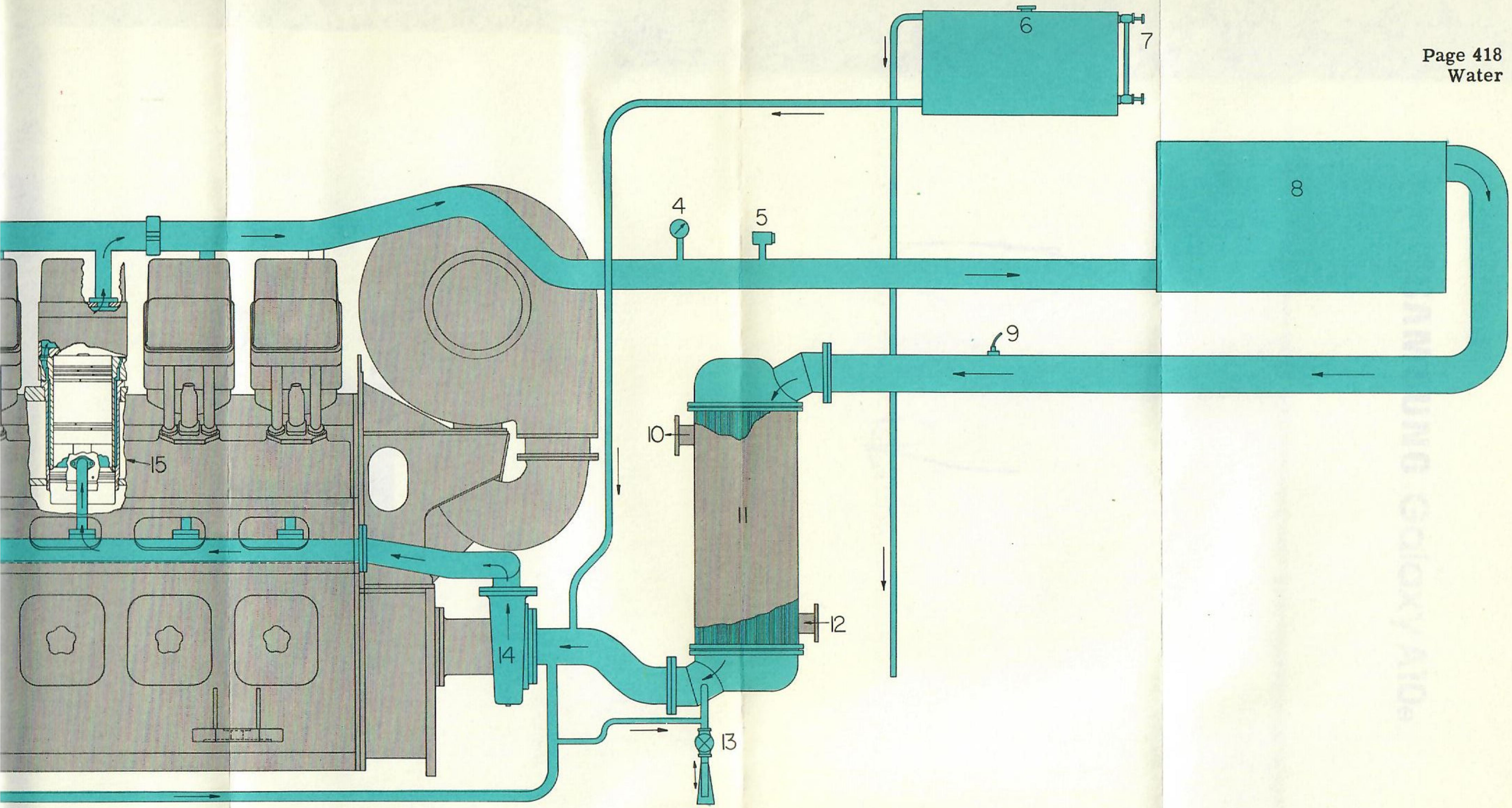
with Fill
Sight Gl
Radiators
Control

FIG. 9-4
COOLING WATER SYSTEM

TP-400
3-1949



1. Cab Heater Water Outlet Valves
2. Cab Heaters
3. Cab Heater Water Inlet Valves
4. Water Temperature Gauge
5. High Temperature Switch
6. Expansion Tank with Filling Connection
7. Expansion Tank Sight Glass
8. Cooling Water Radiators
9. Fan and Shutter Control Thermostat
10. Lube Oil Outlet
11. Lube Oil
12. Lube Oil
13. Fill and
14. Water P
15. Water J



6. Expansion Tank with Filling Connection
7. Expansion Tank Sight Glass
8. Cooling Water Radiators
9. Fan and Shutter Control Thermostat
10. Lube Oil Outlet
11. Lube Oil Cooler
12. Lube Oil Inlet
13. Fill and Drain Valve
14. Water Pump
15. Water Jumper, Jacket and Liner Assembly

FIG. 9-4
COOLING WATER SYSTEM

# GOVERNOR OIL SYSTEM

## DESCRIPTION

**The governor oil system, Fig. 1-5, consists of a reservoir, strainer, pump, filter and low oil pressure switch.**

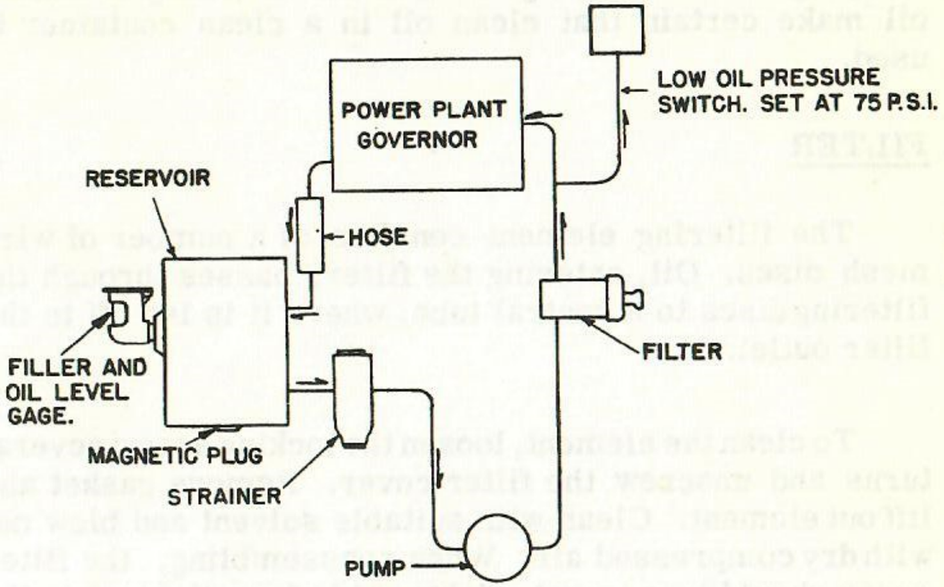

LOW OIL PRESSURE SWITCH. SET AT 75 P.S.I.
POWER PLANT GOVERNOR
RESERVOIR
HOSE
FILTER
FILLER AND OIL LEVEL GAGE.
MAGNETIC PLUG
STRAINER
PUMP

FIG. 1-5
GOVERNOR OIL SYSTEM

**The system operates on 125 psi oil pressure. A motor driven pump receives oil from the reservoir through a strainer and passes it through a filter to the governor under high pressure. A low oil pressure switch is provided which will shut the engine down.**

## RESERVOIR

**Two style reservoirs are in service. One is equipped with a bayonet gauge and has a capacity of 2½ gallons while the other is equipped with a sight glass and vent pipe and has a capacity of 1½ gallons.**

**On the first style, maintain the oil level in the tank at 2/3 full while on the second, maintain the oil level in the sight glass at 1/2 full.**

SAE 10W automotive, non-detergent oil is used in the system. Engine hunting is generally caused by dirt in the governor oil. This condition can generally be corrected by draining and flushing with fuel oil or kerosene. A magnetic plug is located in bottom of the reservoir which attracts metallic particles in the oil. Remove and clean the plug before flushing the system. In filling or adding oil make certain that clean oil in a clean container is used.

## FILTER

The filtering element consists of a number of wire mesh discs. Oil, entering the filter, passes through the filtering discs to a central tube, where it is led off to the filter outlet.

To clean the element, loosen the locking screw several turns and unscrew the filter cover. Remove gasket and lift out element. Clean with suitable solvent and blow out with dry compressed air. When reassembling, the filter cover should be securely tightened before tightening the locking screw, otherwise a gasket leak might occur.

## PUMP

The governor oil pump assembly consists of an electric motor driving a gear type pump through a flexible coupling.

There are two types of governor pumps in service, namely,

1725 RPM-2.75 GPM-125 psi - 1L-X75-AC-Rotation CW
3450 RPM-2.75 GPM-125 psi - 1L-X75-X -Rotation CW

## STRAINER

The strainer element is a brass screen rolled into the form of a cone. To clean the element, remove the screw plug at the top of the strainer, lift out the element, clean with a suitable solvent and blow out with dry compressed air.

## LOW OIL PRESSURE SWITCH

A low pressure switch, similar to the low lubricating oil pressure switches, is provided which will shut the engine down should the pressure drop to 75 psi. For the switch adjustments, refer to Low Oil Pressure Switch -- Lubricating Oil System.

## GOVERNOR

The governor controls engine speed, controls load by matching generator demand with engine ability and controls engine torque at all engine speeds through fuel limit at each throttle position. Throttle positions govern the stop position for the fuel racks and also set up electrical connections for predetermined speeds of the Diesel engine.

To remove the governor, remove the four capscrews which hold the governor to the mounting bracket and lift it straight upward to clear the two locating dowels which position the governor to the mounting bracket. If the governor is to be replaced remove the governor arm and apply it to the new governor. After any governor installation, a dry run should be made to check maximum rack travel.

## NOTES

# AIR SYSTEM

## AIR COMPRESSOR

### DESCRIPTION

Each road locomotive unit is equipped with a Westinghouse Type 3 CDB, three cylinder air cooled, compound type air compressor, rated at 306 CFM displacement at 1000 RPM and 107 CFM displacement at 350 RPM. It is driven from the Diesel engine crankshaft through a flexible coupling.

### INTAKE STRAINERS

The two air intake strainers, one for each of the low pressure cylinders, are of the "cartridge type" which permits removal of the strainer element without the necessity of dismounting or disconnecting from the air compressor. Air passing through the strainer unit enters the compressor intake.

The strainer element should be cleaned periodically. Dirt deposited on the metal wire mesh cover may be dislodged by jarring the strainer and by using dry compressed air. The blast of air should be directed along and not against the strainer unit. The strainer element should then be cleaned in an alkali-free hydrocarbon solvent and dried after which it is dipped and given a lubricating oil bath. After the oil has drained off, it is ready to be put back into service.

### INTERCOOLER

Since this compressor is of the compound type, it is fitted with an intercooler, through which the discharge air from each low pressure cylinder passes to the intake of the high pressure cylinder. The use of an intercooler reduces the temperature of the discharge air and improves the volumetric and power efficiency of the compressor. The intercooler is of the radiator type, employing finned copper tubing mounted between cast iron headers. The intercooler is divided in two halves, one for each of the low pressure cylinders. The low pressure discharge air enters the intercooler through a side header leading to the top or upper header where it is directed down through part of the tubes in the one-half of the intercooler and back up through the remaining tubes in that half. In this way the air from each low pressure cylinder is so directed through its half of the intercooler that, in passing to the high pressure cylinder, the air has traveled approximately twice the length of the intercooler tube. Suitable baffles are employed to insure that the air follows the path desired. After passing the tubes the air enters a common passage leading to the intercooler safety valves and to the inlet side of the high pressure cylinder. Two type E-1 safety valves are employed to protect the intercooler against excessive pressure. These safety valves are set to open at 60 psi.

About the only attention the intercooler should need is draining to insure removal of moisture. Drain the intercooler every time the main reservoirs are drained. A drain cock is located in the bottom header of each bank of intercooler tubes.

When handling the intercooler care should be exercised to avoid damage to the finned tubing and also to see that undue strains are not placed on the header assembly. The top header is one piece while the bottom header is two piece to accommodate expansion due to temperature change. This construction also permits its being lifted off the compressor crankshaft without the necessity of having to disassemble the flexible coupling. The lower headers are tied together by means of a bottom tie strap and capscrews and upon its removal the intercooler may be lifted vertically. When handling, replace the strap to prevent distortion of the assembly.

## COMPRESSOR DETAILS

The compressor consists of two low pressure and one high pressure cylinder. The two low pressure cylinders are the ones at either side and can readily be distinguished from the high pressure one because of their larger diameter. The three connecting rods are of forged steel and are identical. They are applied to a common throw of the crankshaft. Each rod has its individual bearing on the shaft. Lubrication for the crankshaft end of the connecting rod is by pressure feed through the drilled crankshaft. The connecting rod is rifle drilled to the wrist pin which also is supplied with lubricant under pressure.

The cast iron pistons are fitted with four piston rings; two compression and one oil ring above the wrist pin and one oil ring below the wrist pin. All piston rings should be applied so that the scraping edge is toward the crankcase.

Piston wrist pins are of the full floating type and are supported in the connecting rods by means of bronze bushings. The wrist pins are prevented from having excessive end movement by retaining rings which snap in a recess in the piston and thus prevent the wrist pins working out against the cylinder wall.

The main bearings are the radial ball type, one at each end of the crankshaft. They are lubricated by means of "throw-off" from the connecting rod bearings. An oil seal is provided at each end of the crankshaft to prevent oil leakage and also to guard against entrance of dirt.

## INTERNAL OILING SYSTEM

The oiling system is arranged so that oil under pressure is circulated by means of an oil pump. The oil pump is driven by an eccentric at one end of the crankshaft. This pump combines a piston and check valve operating in an oil pump body and is so arranged as to deliver the lubricating oil under pressure to drilled openings in the crankshaft.

The oil supplied to the pump is first filtered. The filter consists of a housing, incorporating a fine screen strainer of large area through which the oil is drawn on its way to the oil pump body. The screen strainer is held in place by a screen retainer which must be removed before the screen can be removed.

The oil gauge should show approximately 15 psi at 500 RPM and should still show pressure at idling speed.

An oil pressure relief valve, mounted in the crankshaft throw towards the intercooler, is provided to protect the oil pump and associated parts against excessive oil pressure.

## LUBRICATION

Lubricating oil is carried in the base of the compressor which is equipped with a bayonet gauge, filler and drain connections, filter and breather. Twelve quarts of Diesel engine crankcase oil should be maintained in the compressor crankcase. For oil change periods, refer to the Lubrication Schedule.

## OIL PUMP AND STRAINER

To dismantle the oil pump, it is first necessary to remove the main bearing end cover on the end of the compressor away from the intercooler. With the crankshaft rotated so that the oil pump plunger is in the vertical position, the entire oil pump plunger and body assembly may be removed by pulling it endwise along the compressor crankshaft.

To remove the oil pump strainer, take out the oil strainer body bolt and pull the strainer assembly out toward the intercooler.

In replacing the main bearing cover, care should be used to enter the end of the oil pump body properly in the cover, which supports it.

## CONNECTING RODS AND PISTONS

The connecting rods are of the split type and are fitted with laminated shims for adjustment. The crankshaft end

of the connecting rod contains the bearing metal which is poured into the rod. Access to the connecting rods and the interior of the compressor for inspection can be made through the side plates on either side of the compressor just below the low pressure cylinders. If, for any reason, it becomes necessary to remove the pistons or connecting rods, the low pressure pistons can be taken out without disturbing the cylinders. They come out through the top of the cylinders after removing the heads.

To remove a high pressure piston, it is necessary to remove the high pressure cylinder before the rod can be taken out. After removal of the cylinder, the piston is lifted out through the opening left by the removal of the cylinder.

## AIR VALVES AND UNLOADER ARRANGEMENT

There are two inlet and two exhaust valves for the low pressure cylinder and two inlet and one exhaust valve for the high pressure cylinder. They are of the double washer type and all are located in the compressor head.

The inlet valves of the two low pressure and of the one high pressure cylinders are equipped with unloaders which are controlled by a governor. They are so arranged that when the compressor has restored the pressure in the reservoir system to the desired point, the compressor will unload and cease to deliver air to the main reservoirs.

The tapped opening in the cap nut of these unloader cylinders connects to a copper pipe header which leads to the compressor governor. When the compressor has reached the desired pressure in the reservoir, the governor admits main reservoir air through this tapped opening in the cap nut onto the face of the unloader valve. This pressure immediately moves the unloader valve in towards the cylinder, carrying with it the intercooler pressure seal valve. This, in turn, acts through the unloader plunger which has as a part of the plunger, a head with four fingers or prongs on its lower side. These prongs extend through openings in the inlet valve seat. With the pressure admitted as described above, these fingers will push the inlet valves off the seat and the compressor is then unloaded, as no compression takes place as long as the inlet valves are thus held open. Complete movement of the unloader valve on which the main reservoir pressure first acted, results in its seating and preventing leakage of main reservoir air through the unloader assembly to the atmospheric vent.

When the pressure in the main reservoir has dropped to the point where it is desired to cause the compressor to operate, the governor assumes the "cut-in" position which vents main reservoir air from the face of the unloader valve. The return and unloader springs then move the unloader valve outward, carrying with it the unloader plunger and the four fingers which unseated the inlet valves. The inlet valves are seated then by the valve springs and the compressor resumes delivery of air to the main reservoir.

## DISCHARGE VALVES

If for any reason, it is desired to remove or inspect the discharge valves, it is only necessary to remove the cap nut, and then back out the valve plug, using a rectangular bar wrench 1/2" x 1/2" x 3' long, which fits into rectangular slots on the face of the plug. A large monkey wrench will be necessary to turn the bar, or a "T" handle wrench with 1/2" x 1/2" head might be more suitable. After removal of the valve plug the complete discharge valve assembly can be lifted out, the seat, valves, springs and spring retainer being held together by a stud, castle nut and cotter pin.

## INLET VALVES

The inlet valves are held in place by the unloader body, and an inlet valve plug like that described for the discharge valve. To remove the inlet valve assembly, first remove the unloader body and lift out the unloader valve assembly. Back out the inlet valve plug, using the bar wrench as described for the discharge valve, which will free the inlet valve assembly and permit its removal. The valve assembly -- seat, valves, springs and spring retainer -- are held together by a stud, castle nut and cotter.

## REPLACING INLET AND DISCHARGE VALVE ASSEMBLIES

When replacing inlet and discharge valve assemblies in the cylinder head it is important that the copper gasket between the head and valve seat, is in good condition. Generally, it is better policy to replace this gasket with a new one when reassembling. The same gasket is used for all inlet and discharge valve assemblies.

It is also important to make absolutely certain that valve assemblies are replaced with the castle nut side pointing outward, i.e., away from the compressor piston. In some instances it might be possible to turn an assembly over and, should this be done, serious damage to the compressor might result if operated under this condition.

The valve and valve springs of all inlet and discharge valve assemblies are completely interchangeable. The inlet and discharge valve seats are not interchangeable. All inlet valve assemblies have the same valve seat; all discharge valve assemblies have the same valve seat.

## CRANKCASE BREATHER

The compressor crankcase is vented by means of a breather with cap. It has a quantity of copper gimp, supported between suitable screens retained in place by means of a snap ring. The breather is also fitted with a check valve so arranged that any pressure in the crankcase will be relieved to atmosphere, but any tendency for air to flow from the outside of the compressor into the crankcase is prevented. This check valve is felt-sealed for quiet operation.

## ORIFICE TEST

Using a 17/64" orifice and running the compressor at 550 RPM (Throttle Notch 3) the following table shows the condemning limit pressures at various altitudes.

| Elevation (ft.) | 0 | 1000 | 2000 | 3000 | 4000 | 5000 | 6000 | 7000 | 8000 |
|---|---|---|---|---|---|---|---|---|---|
| Condemning Limit (psi) | 102 | 98 | 94 | 90 | 86 | 82 | 78 | 75 | 71 |

## AIR COMPRESSOR GOVERNOR

### TYPE - NS16

This governor is of the pneumatic double "safety valve" type and consists of two distinct portions; the operating portion and the pipe bracket. Pipe connections to the compressor and to the main reservoir are provided for in the pipe bracket so that the operating portion may be removed for repairs or replacement without breaking any pipe joints.

The operating portion casting is marked HP and LP. The adjusting screw in the HP section is used to regulate the point of air compressor cut-out or unloading point while the adjusting screw in the LP section is used to regulate the point of air compressor cut-in or loading point. Therefore, it is necessary to set two pressures when adjusting the governor, the High pressure, where the governor unloads the compressor and the Low pressure, where the governor loads the compressor.

To adjust governor pressures, loosen both lock nuts where the adjusting stems protrude from the top of the

governor and screw cut-out regulating stem (HP side) down until the desired cutting-out point is reached. A main reservoir air pressure gauge is located near the governor for use when making pressure adjustments. At the same time screw down cut-in regulating stem (LP side) to as nearly the same tension as can be judged under ordinary observation. If when the cutting-out point is reached the range is not as desired, screw the cut-in regulating stem down to raise the cutting-in point or to decrease the range and back it off to lower the cutting-in point or to increase the range.

This governor needs very little attention after being properly adjusted except to be cleaned and oiled periodically. When cleaning and oiling the governor, a few drops of good oil should be placed on the surface passed over by the cutting-in and cutting-out valves. See also that the exhaust opening is free from dirt or gum and the strainer is clean.

### TYPE S16

If locomotives are equipped with air compressor synchronization, Type S16 governor is used. This type of governor, in addition to the operating portion and pipe bracket, also has an air operated switch which controls current to a magnet valve in each locomotive unit. The magnet valve controls the flow of main reservoir pressure to the air compressor unloader valves in its unit. By means of this control, all air compressors are either loaded or unloaded simultaneously.

Governor maintenance instructions and pressure adjustments are made the same as on the NS16 governor. The switch has self-contained contact fingers and bases, encased in moulded insulation, and can be readily removed as units, without special tools. The finger adjustment is permanent and accomplished without use of screws. An efficient pneumatic blow-out when the governor cuts out, in combination with the peculiar shape of the contacts, insures that the opening arc is definitely lengthened, cooled and then effectively extinguished.

## TESTING SAFETY VALVE

In order to test a main reservoir safety valve it is necessary to keep the air compressor loaded above the governor high pressure setting. In order to accomplish this, close the governor air supply cut-off valve. This prevents main reservoir pressure reaching the air compressor unloader valves and thereby keeps the compressor loaded.

## AIR SYSTEM

From the compressor on road locomotive units, air passes a safety valve set at 175 psi as it goes through the floor from the compressor. The purpose of this safety valve is to protect the compressor against plugging of the discharge line through freezing, damage, etc. The air then passes through cooling pipe and enters the No. 1 main reservoir under the frame, right side. Air flow from the No. 1 main reservoir passes through air cooling pipe and then is divided; part flows through a check valve, past a 150 psi safety valve which protects the main reservoirs, into the No. 2 main reservoir under the frame, left side, while the other part is used for the operation of the control air system, radiator shutter system, bell ringer, horn, windshield wipers and sanders. Air from the No. 2 main reservoir is used for the air brake system only.

From the compressor on road switcher locomotives, air enters the No. 1 main reservoir under the frame, right side and flows through air cooling pipe past a safety valve to the No. 2 main reservoir. Air supply lines are connected to the pipe between the main reservoirs which furnish air for the operation of the air compressor governor, sanders and radiator shutter system. Air from the No. 2 main reservoir is used to operate the air brake system, control air system, horn and window wipers.

## CONTROL AIR SYSTEM

Air pressure is used to operate the reverser, series and parallel contactors, and dynamic braking switch, if used. In each road locomotive unit, air pressure is supplied from the No. 1 main reservoir and is reduced to 70 psi by an NS-1 reducing valve. On the road switcher, main reservoir pressure is supplied from the No. 2 main reservoir.

Built into the NS-1 reducing valve is a cutout cock, strainer and check valve. The control air then flows to a control air reservoir equipped with a drain valve and then to the reverser, electro-pneumatic contactors and to dynamic braking switch (on locomotives equipped with dynamic brake).

On the road locomotive the control air system, including the gauge, is located in the nose mounted on the bulkhead separating the nose from the cab while on the road switcher, the control reservoir is located under the underframe, between the battery boxes, and the NS-1 reducing valve is located in back of the battery box, right side. The control air pressure gauge is mounted on the panel directly in front of the engineer.

If the gauge should indicate pressure other than 70 psi, the trouble will probably be found in the NS-1 reducing valve. The air system has to be blown down before this valve can be removed. If high pressure is indicated no serious difficulties should be experienced before the trouble is corrected. However, low pressure will cause the electro-pneumatic contactors and reverser to become inactive with the result that the locomotive will not move.

## DRAINING AIR SYSTEM

The air system should be drained periodically to prevent moisture from reaching the air brake and control air systems.

Drain the following:

1. Air compressor intercooler -- both sides.
2. Main air reservoirs.
3. Filter in Minneapolis-Honeywell supply line.
4. Control air reservoir.
5. Filter - Lubricator in shutter air system.

## SANDING

"A' units are equipped with air operated sanders in forward movement only. "B" units have electro-magnetic sanders for forward and reverse movement while road switching locomotives have air operated sanders for the front wheels of the front truck and back of the back wheels, rear truck.

Sand is obtained by operating the engineer's sander valve. Actuating air from the engineer's valve controls the flow of main reservoir air through the sander automatic valve to the sand traps.

On the "B" units forward and reverse sanding is controlled from the engineer's sander valve in the leading unit, through the reverser in the "B" unit. Electrical connections from the forward or reverse position of the "B" unit reverser control the operation of magnet valves. Actuating air from these magnet valves control the flow of main reservoir air through automatic sander valves to the forward or reverse sand traps.

To increase the amount of sand flow turn the nozzle adjusting nut, located at the sand trap, clockwise and to decrease the sand flow turn the nozzle adjusting screw counterclockwise.

## BELL AND RINGER

The bell, located behind the pilot, is operated by air pressure controlled by the operating valve at the engineer's position. The clapper speed is regulated by a needle valve adjustment at the bell.

## AIR BRAKE SYSTEM

For maintenance information on the 24 RL brake equipment used on the road locomotive refer to Westinghouse Air Brake instruction pamphlet. For instructions on the operation of road switcher locomotives refer to Westinghouse Air Brake instruction pamphlet covering 6 DS equipment.

## WINDSHIELD WIPERS

With the windshield wiper valve turned to maximum opening, the wiper should make sixty-five plus or minus five single strokes per minute. If the wiper blade exceeds this rate, adjustments should be made as follows:

1. The pressure regulator is fitted with a stop knob which stops the regulating screw from being turned too far toward the "on" position. This prevents the operation of the wiper at excessive speeds which results in damage to the equipment.

2. Remove the stop knob after loosening the two set screws.

3. Turn the regulator screw until the wiper speed is 65 plus or minus 5 strokes per minute.

4. Place the stop knob over the end of the regulating screw, push it flush against the regulator body and tighten the two set screws.

## SHUTTER CONTROL

The opening and closing of the radiator shutters is accomplished by using main reservoir air pressure in the double acting shutter operating cylinders. The flow of air in and out of the cylinders is controlled by a magnet valve and a reactionary valve.

Air from the main reservoir flows through a shut-off valve and filter-lubricator and then to one side of both the magnet valve and reactionary valve.

When the magnet valve is energized the shutters are closed due to the fact that air flows through the magnet valve to one side of the shutter operating cylinder. The air also flows to the other side of the reactionary valve, which causes the reactionary valve to move, with the aid of an internal spring, exhausting the air through an exhaust port from the opposite side of the shutter cylinder.

When the magnet valve is de-energized the shutters are opened. Air is exhausted through an exhaust port in the magnet valve from one side of the shutter cylinder and from one side of the reactionary valve.

Main reservoir air on the opposite side of the reactionary valve causes the valve to reverse its movement which allows air to flow to the shutter cylinder causing the shutters to open.

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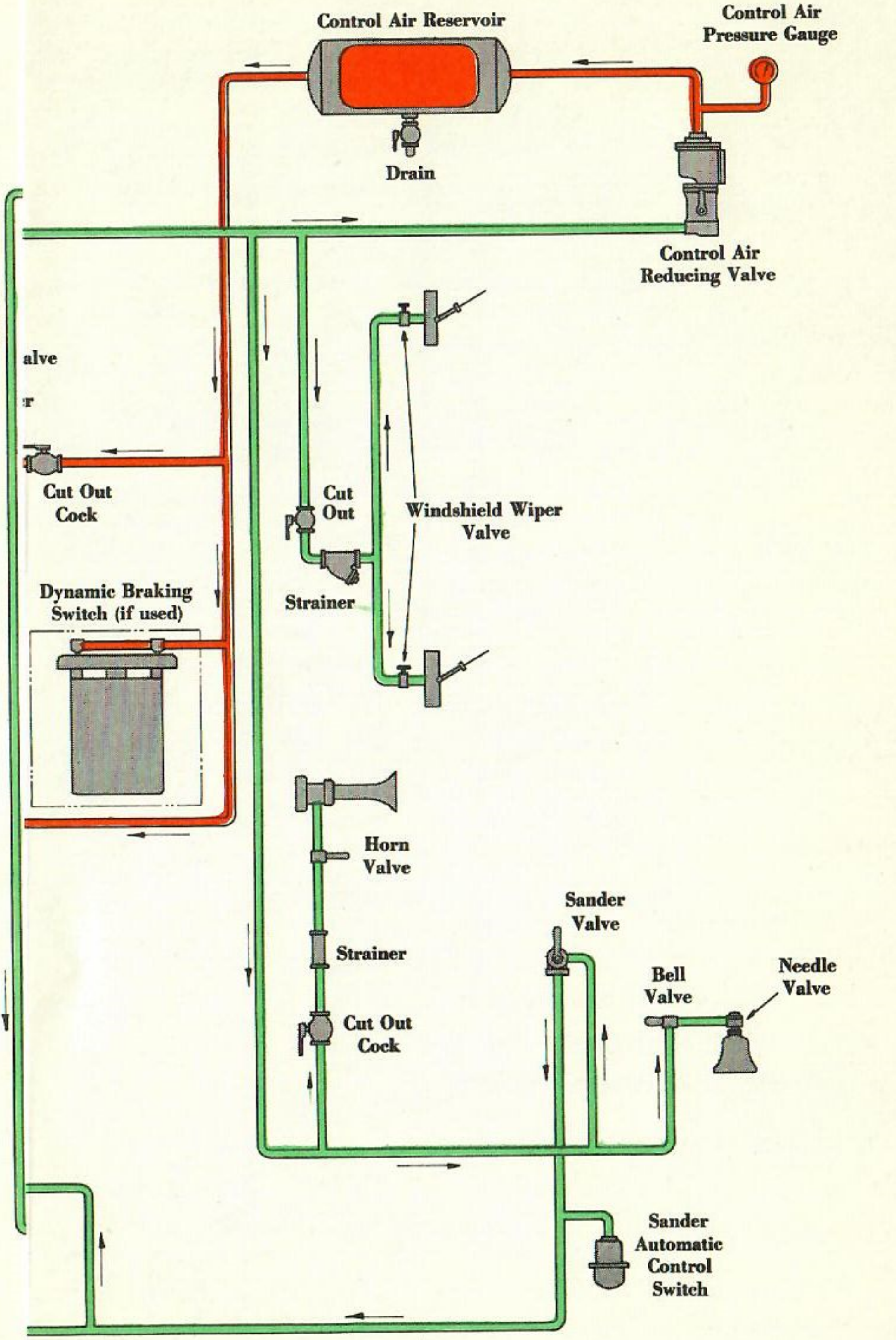
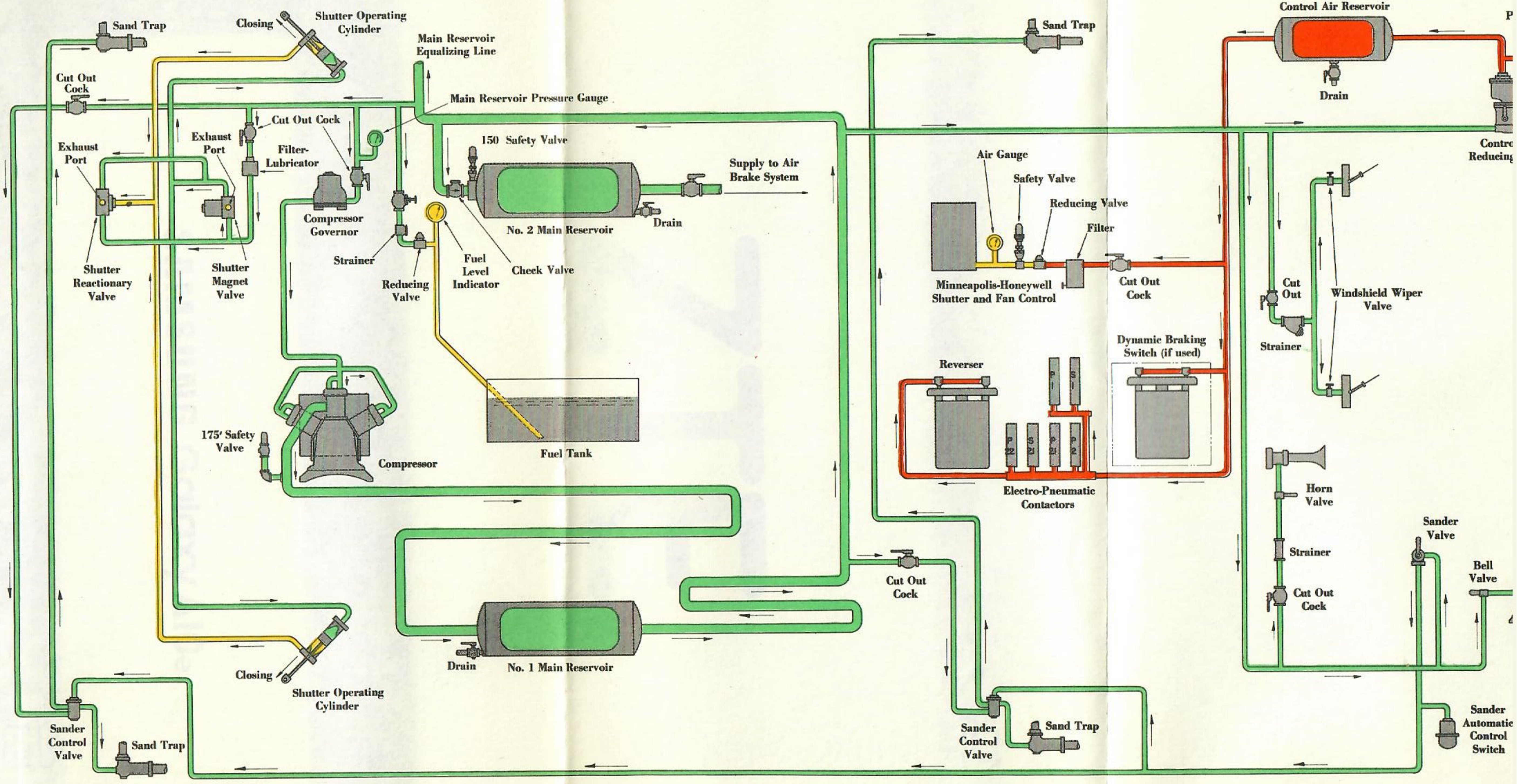

Control Air Reservoir
Control Air Pressure Gauge
Drain
Control Air Reducing Valve
alve
r
Cut Out Cock
Cut Out
Windshield Wiper Valve
Strainer
Dynamic Braking Switch (if used)
Horn Valve
Sander Valve
Strainer
Bell Valve
Needle Valve
Cut Out Cock
Sander Automatic Control Switch

FIG. 1-6
AIR SYSTEM


Sand Trap
Closing
Shutter Operating Cylinder
Main Reservoir Equalizing Line
Cut Out Cock
Main Reservoir Pressure Gauge
Cut Out Cock
Exhaust Port
Exhaust Port
Filter-Lubricator
150 Safety Valve
Supply to Air Brake System
Compressor Governor
No. 2 Main Reservoir
Drain
Shutter Reactionary Valve
Shutter Magnet Valve
Strainer
Reducing Valve
Fuel Level Indicator
Check Valve
175′ Safety Valve
Compressor
Fuel Tank
Drain
No. 1 Main Reservoir
Closing
Shutter Operating Cylinder
Sander Control Valve
Sand Trap
Sand Trap
Control Air Reservoir
Drain
P
Contr
Reducing
Air Gauge
Safety Valve
Reducing Valve
Filter
Minneapolis-Honeywell Shutter and Fan Control
Cut Out Cock
Cut Out
Windshield Wiper Valve
Strainer
Dynamic Braking Switch (if used)
Reverser
P 1
S 1
P 22
S 21
P 21
P 2
Electro-Pneumatic Contactors
Horn Valve
Strainer
Cut Out Cock
Cut Out Cock
Sander Valve
Bell Valve
Sander Control Valve
Sand Trap
Sander Automatic Control Switch

FI
AIR

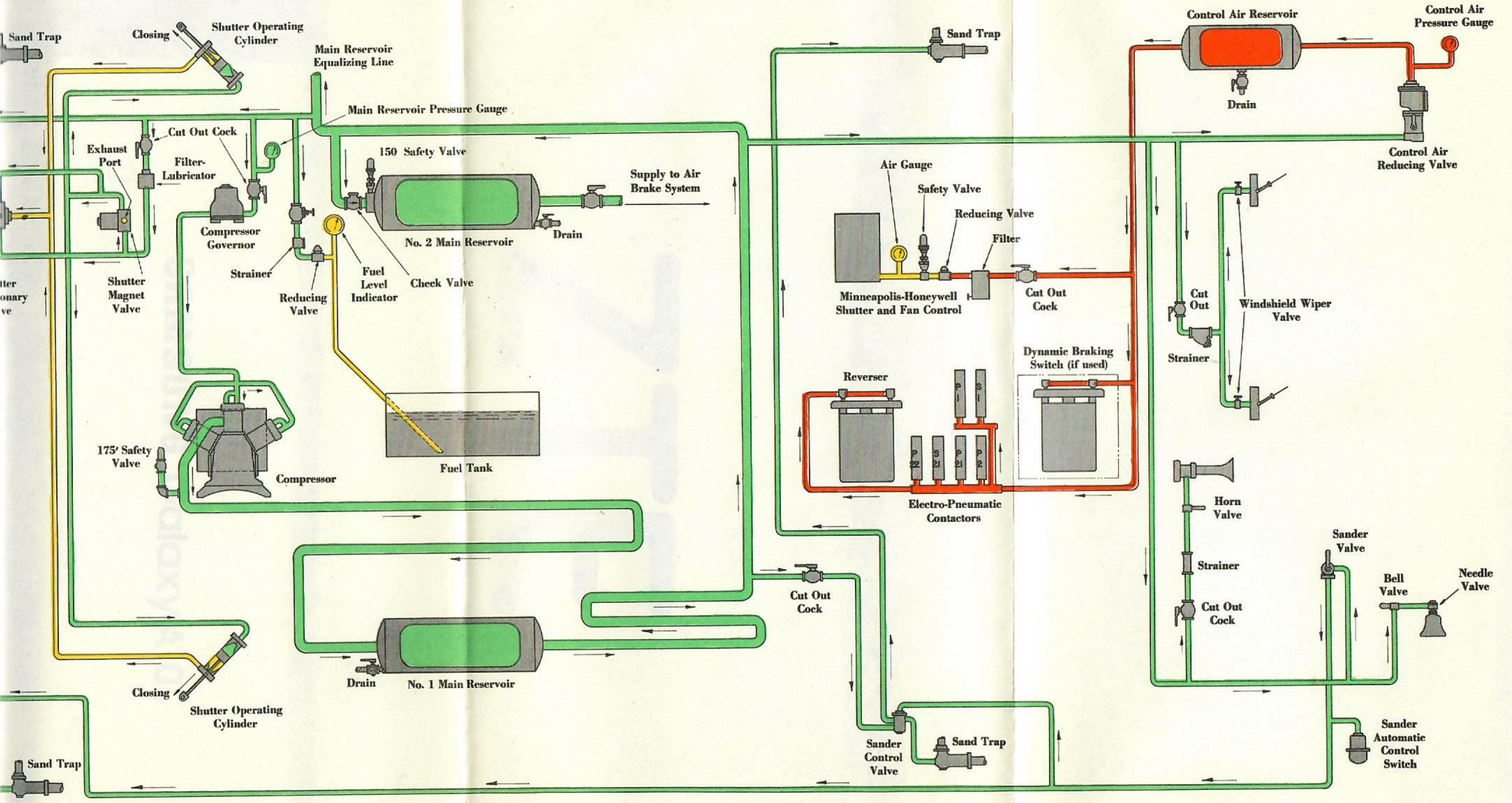

Sand Trap
Closing
Shutter Operating Cylinder
Main Reservoir Equalizing Line
Main Reservoir Pressure Gauge
Cut Out Cock
Exhaust Port
Filter-Lubricator
150 Safety Valve
Supply to Air Brake System
Compressor Governor
No. 2 Main Reservoir
Drain
Strainer
Reducing Valve
Fuel Level Indicator
Check Valve
tter
onary
ve
Shutter Magnet Valve
175′ Safety Valve
Compressor
Fuel Tank
No. 1 Main Reservoir
Drain
Closing
Shutter Operating Cylinder
Sand Trap
Sand Trap
Control Air Reservoir
Control Air Pressure Gauge
Drain
Control Air Reducing Valve
Air Gauge
Safety Valve
Reducing Valve
Filter
Minneapolis-Honeywell Shutter and Fan Control
Cut Out Cock
Dynamic Braking Switch (if used)
Reverser
Electro-Pneumatic Contactors
Cut Out
Strainer
Windshield Wiper Valve
Horn Valve
Strainer
Cut Out Cock
Cut Out Cock
Sander Control Valve
Sand Trap
Sander Valve
Bell Valve
Needle Valve
Sander Automatic Control Switch

FIG. 1-6
AIR SYSTEM

# CHASSIS

## TRUCKS

Before an axle and wheel assembly, with or without traction motor, or a complete truck can be removed from beneath a locomotive unit it is necessary to relieve the truck or trucks of the chassis weight. The jacking and lifting diagram shows the locations at which the units may be supported either by jacks, a lifting rig used in conjunction with an overhead crane, or by stationary body supports frequently included with drop table installations. Tables on the jacking and lifting diagram show approximate loads involved. The following precautions should be observed: Wood blocking should be used between chassis support points and lifting devices and lifts should be uniform on both sides of unit to prevent unnecessary strain on cab structure. The cab should not be lifted more at one end than at the other until the body center castings have become disengaged from the truck center plates.

## REMOVING WHEELS AND AXLES

To remove a wheel and axle assembly without removing the truck it is necessary to use a drop table. Support the chassis weight and block under the equalizers. Remove the pedestal tie bars, brake bottom pull rods, motor nose suspension spring unit, axle suspension bearing caps and gear case. Disconnect the axle driven equipment as necessary. Support the motor from the underframe by turnbuckles shackled into lifting eyes cast into the motor frame. Pull the motor toward the center of the truck approximately two inches to disengage the pinion from the axle gear and lower the wheel and axle assembly.

To remove a wheel and axle assembly with the traction motor attached it is necessary to use a drop table. Support the chassis weight and block under the equalizers. Remove the pedestal tie bars, brake bottom pull rods and motor nose suspension spring unit. Disconnect the traction motor leads, air duct and axle driven equipment as necessary. Block between motor and table and lower the assembly.

REMOVING TRUCKS

To remove an entire truck, disconnect the safety hooks, traction motor air ducts (freight only), air brake piping, traction motor leads and axle driven equipment as necessary. The lift required will be lessened if blocking is provided between journal box and pedestal tie bar so that the coil equalizer springs cannot raise the frame.

A truck may then be removed by three different procedures:

If a drop table is used the chassis should be supported either by stationary body supports bridging the table or by means of a lifting rig which requires an overhead crane.

Trucks may be removed laterally after raising the chassis sufficiently to disengage the center castings from truck center plates and to provide proper clearance above the trucks. Use either a lifting rig or jacks. When using jacks to remove the front truck on a passenger or freight locomotive, it is necessary to first remove the side ladder below the operating cab door. It is also necessary to remove a section of the pilot on passenger locomotives.

Trucks may be removed longitudinally along the track after raising the chassis sufficiently to clear the draft gear housing or the pilot. The lift required will be lessened if the pilot, rear end side ladders and uncoupling rigging support brackets are removed.

---

Refer to jacking and lifting diagram for details of lifts and loads involved.

REMOVING COIL SPRINGS ON 4 WHEEL TRUCK

1. Jack up locomotive about 2" more than the distance from bottom of equalizer hook to top of pedestal projection below equalizer.
2. After removing pedestal tie bars jack up truck frames until top of pedestal projection contacts bottom of equalizer hook.
3. Remove coil springs.

REMOVING ELLIPTIC SPRINGS ON 4 WHEEL TRUCK

1. Jack up locomotive about 2" more than enough to take load off truck.
2. Remove strap above bolster. With an adapter to straddle spring plank at center of truck jack up bolster about same amount as underframe. (This should not be done with locomotive weight on bolster.)
3. Jack up spring plank close to hanger just enough to take the weight of plank and springs off hanger.
4. Push swing hanger until it touches equalizer and lower one end of spring plank.
5. Unseat spring and move out over equalizer as far as possible.
6. Jack up truck frames until spring may be removed out the side.

## REMOVING COIL SPRINGS ON 6 WHEEL TRUCK

1. Jack up locomotives a sufficient amount (somewhat more than distance from bottom of equalizer hook to pedestal below this hook) thereby taking weight off truck and to allow for jacking truck frame.

2. Jack truck frame until pedestals contact bottom equalizer hook after removing tie bars and equalizer safety stops.

3. Remove coil springs.

## REMOVING ELLIPTIC SPRINGS ON 6 WHEEL TRUCK

1. Jack up locomotive a sufficient amount to allow about 2" more than required to let full elliptic spring go free.

2. Jack up bolster about same amount as locomotive.

3. Jack up spring planks close to hangers after removing spring plank safety strap to take the weights off spring plank and springs. Push swing hanger until it touches equalizer and lower one end of spring plank.

4. Jack up truck frame and remove springs from side over equalizer.

## BATTERY

The locomotive storage battery is the heart of the electrical system. Its primary duty is engine cranking and it also furnishes current for control and lighting circuits.

The battery is made up of 32 cells, four in each of eight trays. Four trays are carried in the battery box on each side of the locomotive unit. The life of the battery will be prolonged by regular inspections, recording conditions and taking immediate corrective steps as necessary.

When a new battery is received the electrolyte level in all cells should be checked. If the level is more than 1/8" below the bottom of the filling tubes, add electrolyte of the same specific gravity and check to see if cells are leaking.

Before adding water to the battery, check and record the specific gravity of one cell in each half of the battery. Since a small quantity of electrolyte may be lost each time a gravity reading is taken, a system of rotating readings around the cells of each half of the battery will prevent any individual cell from losing electrolyte excessively. This rotation can best be accomplished by having one white colored vent plug which can be advanced one cell in the series circuit each time a reading is taken so as to indicate the cell to be read at next inspection.

Record the water level in same cell checked for specific gravity. Water additions should be required only at monthly intervals and the cause for more frequent water additions should be investigated.

## BATTERY CHARGING

The battery is charged by current supplied by the auxiliary generator, the output voltage of which is controlled by a voltage regulator which should maintain constant voltage across the battery at all engine speeds. The normal setting of 74 volts should maintain a full charge without using excessive water or heating up the battery. However, the setting may have to be varied depending upon the working schedule of the locomotive and seasonal temperature conditions.

Before changing setting of voltage regulator observe specific gravity and water level variations over a period of several days and then make adjustment only after at least one hour operation so that regulator coils are at normal operating temperature.

If periodic readings show a decrease in specific gravity and water consumption indicates a rate of less than 1/4" per month the charging voltage should be increased, but in steps not to exceed 1 volt. The battery condition should then be checked after three days operation and voltage raised again if necessary.

If the specific gravity readings show a full charge is being maintained but water consumption shows a rate of more than 1/2" per month or the battery is heating, then the regulator output should be reduced in 1/2 to 1 volt steps until normal conditions are maintained.

Record all voltage regulator changes on battery record card.

## GENERAL RULES

Specific gravity readings must be corrected for both electrolyte temperature and level and must be taken before water is added. Obtain proper corrective data for battery being serviced.

Add only distilled or approved water at regular intervals. Do not fill higher than 1/8" below bottom of filling tube.

In freezing weather add water only when locomotive is going into service as water will not mix with electrolyte except during charging periods.

Clean, tight connections help to prevent starting failures. Contact surfaces and connector bolts should be properly greased and connector bolts tightened with two 6" box wrenches to prevent undue strain on terminal posts.

Battery should be cleaned with a hot soda solution (1 lb. to the gal.) preferably brushed on and then thoroughly rinsed with clear water.

Do not connect any electrical load across a portion of the battery because the cells involved would be discharged below the level of the remaining cells.

Keep vents in filler caps clear as internal cell pressure could easily cause cell leakage.

## BATTERY DATA

| Manufacturer | Identification Number | Specific Gravity Fully Charged |
|---|---|---|
| Exide | MV-25-D | 1.250 |
| Philco or Gould | 25 -SVTB | 1.250 |
| Gould | KMH-25 | 1.250 |

## AUXILIARY DRIVES AND HP REQUIREMENTS

| Equipment | Horsepower |
|---|---|
| Air Compressor | |
| Unloaded at 1000 RPM | 23 |
| Loaded at 1000 RPM and pumping against M. R. Pressure | 75 |
| Amplidyne | 8 |
| Auxiliary Generator | 17 |
| Traction Motor Blower Generator | 17 |
| Radiator Fan | |
| Freight and Passenger | 75 |
| Road Switcher | 58 |

## ALIGNMENT OF AUXILIARY DRIVES

## FALK COUPLING AND AIR COMPRESSOR

Heat both hubs in an oven or by induction to 200° F for 20 minutes and apply to shafts. This will give approximately .012" advance. Align the air compressor so that the hub faces are 3/8" apart, with a maximum indicated runout between the vertical faces of the coupling halves of .020" and parallel within .002". Shaft keyways must be lined up before connecting coupling hubs. The crankshaft extension runout must not exceed .006" indicator reading both before and after connecting coupling.

## FAST COUPLING, EDDY CURRENT CLUTCH AND RIGHT ANGLE GEAR BOX

1. Heat both hubs in an oven or by induction to 200°F for 20 minutes and apply to shafts. This will give approximately .012" advance. Bolt horizontal radiator fan drive shaft to eddy current clutch. Tighten bolts to 160 - 180 ft. lbs. Shift the right angle gear box until the ends of the shafts on which the Fast coupling is attached are 1-1/16" apart. Connect the Fast coupling.

2. Mount dial indicator on coupling case and rest the stem of the indicator on the shaft driving the eddy current clutch. With the dial indicator in a vertical position, pry up on the shaft and note deflection.

3. If the deflection is more than .008", the shaft must be shimmed circumferentially in the flexible half of the Fast coupling so as to be centrally located in the housing. Remove the dial indicator.

4. Bar the engine over until one of the jacking holes in the Fast coupling is on top.

5. Apply a jig approximately 22" long to this jacking hole and attach a dial indicator with the stem resting on the shaft.

6. Take readings at zero, 90°, 180°, 270° and check zero setting at 360°. The differential between zero to 180° and between 90° to 270° should not exceed .008".

7. If the differential in either the horizontal plane or the vertical plane exceeds .008", the gear box unit must be shifted accordingly.

CAUTION - When adding or removing shims, be sure that the same thickness is used on all four corners of the gear box. Also, when shifting the gear box unit laterally, be sure that the unit is shifted as a whole and not just pivoted on one of its mounting bolts.

8. Mount a dial indicator on the vertical face of the eddy current clutch inner rotor on the gear box side with the indicator stem resting on the vertical face of the outer rotor and at a right angle to the vertical face of the outer rotor.

9. Rotate inner rotor and note deflection. If deflection exceeds .070", shim the gear box accordingly.

10. A .035" air gap should exist between the inner and outer rotor.

11. Recheck shaft runout at flexible coupling so as not to exceed .008".

12. If shims were used in Fast coupling to centralize shaft be sure they are removed upon completion of alignment.

## NOTES

# DIESEL ENGINE

## WATER JACKET TO CYLINDER BLOCK ALIGNMENT

The cylinder liner, water jacket, piston and connecting rod are removed as a unit. However, in reapplying this assembly it is necessary to position the liner and water jacket until the half-moon cutout in the water jacket fits over the locating dowel in the cylinder block. This arrangement definitely locates the liner and jacket assembly with relation to water jumpers, water passages to the cylinder heads, etc.

In some cases scribe marks are used for locating the liner and jacket assembly, in which case make certain that the scribe marks on the liner, water jacket and cylinder block are line-in-line.

## PISTON RINGS

Before applying piston rings make certain that the inside top and bottom corners "A" and the top and bottom corners of the ring gap "B" are broken with a 1/64" radius, Fig. 1-8.

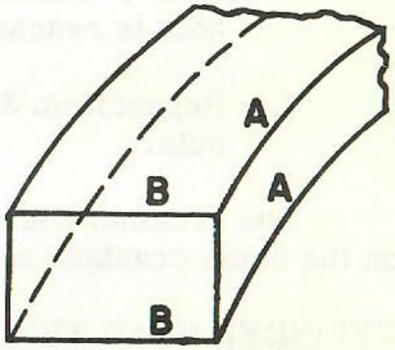


FIG. 1-8
PISTON RINGS

## ASSEMBLING CONNECTING ROD AND PISTON

When applying a piston to a rod the discharge hole in the oil cooling portion of the piston should be to the left when facing the "O" marks on the connecting rod.

When applying a piston and rod assembly to an engine, the "O" mark should face the outside of the engine.

Caps of different connecting rods are not interchangeable --- do not mix them up.

## TIGHTENING CONNECTING ROD BEARINGS

The following instructions should be adhered to when tightening the connecting rod bearings:

1. Lubricate all faces, seats and threads with engine lubricating oil.
2. Tighten all nuts evenly to about 20 ft. lbs. torque, (one man on 6" wrench) starting with nuts on side toward center of engine, then tighten all nuts following the original tightening order to 100 ft. lb. torque (one man on 18" wrench).
3. Loosen one nut, measure overall free length of the bolt and tighten until bolt elongation is .015". Continue tightening until the cotter pin hole is reached.
4. Repeat item 3 successively on remaining three nuts.

The accumulated side clearance between two rods on the same crankpin should be within .018" - .028".

## CYLINDER HEAD TIGHTENING

When applying a cylinder head have the head square and in line with the remaining heads by using a straight edge across the outside machined surface of the heads. Snug up the small nuts with enough pressure to compress the water passage gaskets. Tighten the crab nuts by moving the wrench diagonally from one nut to another and then retighten the small nuts. The squaring up of the heads is very important for the sealing of the exhaust manifold to the head. Recheck the head alignment after the crab nuts have been tightened.

The following table lists the number of men and the length of wrench extension to be used when tightening the various head nuts by hand and also the approximate foot pounds required when tightening the heads with a torque wrench.

| Description | Stud Size | Length of Wrench | No. of Men | Approx. Ft. Lbs. |
|---|---|---|---|---|
| 1 Rear Nut | 1-1/4" | 4 ft. | 1 | 850 |
| 2 Front Nuts | 1-1/8" | 3 ft. | 1 | 600 |
| 4 Crab Nuts | 1-5/8" | 5 ft. | 2 | 1200 |

"Powerench" ratio between output and input is 5.2 to 1.

When clamping the exhaust manifold to the cylinder head, the aligning mark on the exhaust manifold elbow flange should be within 3/16" of the mark on the cylinder head. The top edge of the flange should be within 1/8" of being flush with the cylinder head.

## ADJUSTING AIR AND EXHAUST VALVE CLEARANCE

Set turning device timing gear at 18° B.T.C. for the cylinder on which the valves are to be adjusted. Valve clearance should be .012" for each of the four valves whether hot or cold.

Loosen the adjusting screw at the push rod end of the valve lever until a .012" feeler can be inserted between the non-adjustable end of the valve equalizing yoke and the valve stem. Leave this feeler in place and tighten the adjusting screw at the push rod end holding the adjusting screw while tightening the lock nut.

Without removing the first feeler loosen the adjusting screw on the equalizing yoke until a second .012" feeler can be inserted between the adjusting screw and the valve stem. With the feeler in place, hold the adjusting screw while tightening the lock nut.

Move both feelers simultaneously to make certain that there is the proper valve clearance.

## CHECKING CRANKSHAFT THRUST

To check crankshaft thrust, first pry the crankshaft toward the generator end and then toward the free end. Use a pinch bar between any of the main bearing caps other than the thrust bearing (nearest the generator) and the crank web. Check the clearance between the face of the thrust bearing and the shoulder of the crank web. Never pry against the thrust bearing cap as the bearing face may become damaged which will result in a bearing failure.

## PISTON RING BREAK-IN

After new piston rings have been applied, it is not necessary to idle the engine to "break in" the rings. Experience has shown that there are no harmful affects resulting from placing the locomotive in normal service immediately following the application of new piston rings.

## CAMSHAFT TIMING

A quick check to determine whether or not the camshaft is ''in time'' may be made by the use of a dial indicator with a suitable holding clamp. Remove a fuel injection pump and mount the indicator so that it bears directly on the cam follower in a perpendicular position. Rotate the engine in the direction of rotation (clockwise when viewed from the free end).

With a cam lift of 0.229" the crankshaft setting should be 15° before top center.

## CRANKSHAFT DEFLECTION

The crankshaft deflection should be checked after:

1. Installation of engine-generator set.
2. Application of traction generator to engine.
3. Renewal of main bearings.
4. Installation of air compressor.
5. Installation of air compressor drive coupling.

Excessive crankshaft deflection may cause the following conditions:

1. Main bearing failures.
2. Noisy air compressor.
3. Noisy air compressor drive coupling.
4. Crankshaft failure.

There are two bolting pads on each side of the generator below the horizontal centerline which are provided with 3/32" shims, tack welded in place. The bolting pads near the top also have shims, but these shims are less than 3/32" so that the end of the generator will be tilted up slightly. Shaft deflection is corrected by increasing or decreasing the amount of shim thickness at the top pads.

1. With the crank nearest the generator on top vertical center, place a crankshaft deflection gauge between the webs 3/8" up from the bottom edge. The gauge should be parallel to the axis of the shaft and 180 from the centerline of the crankpin with dial set at zero. Under no condition should this setting be disturbed while checking crankshaft deflection.

2. Rotate crankshaft clockwise as far as possible without indicator striking connecting rod. Note and record indicator reading.

3. Rotate crankshaft counterclockwise as far as possible without indicator striking connecting rod. Note and record indicator reading.

4. The indicator must not show more than plus or minus .0015" deviation at any of the three points on crankshafts with counterweights or .00075'' deviation on crankshafts without counterweights. If the deviation exceeds these figures correction must be made by changing shims.

## TURBOSUPERCHARGER MOUNTING

When applying a turbosupercharger, a clearance of .005" - .008" should exist between the turbosupercharger bracket and the air manifold after tightening the bolts. If this clearance does not exist, remove lock screws and bushings and renew the bushings.

## CRANKCASE EXHAUSTER

An indicating light is provided to warn the operator when the crankcase exhauster is inoperative. The light should be lit during engine operation. In the event of failure of this piece of equipment while enroute the engine should be shut down. However, if it is known that the engine is in good mechanical condition, it is safe to continue normal operation until the next maintenance terminal is reached where the trouble should be corrected before the locomotive is dispatched.

## ENGINE BALANCING

Generator fans are dynamically balanced and may or may not have fan balancing weights welded in place. Under no circumstance should the welded weights be removed. Fans are therefore applicable to and interchangeable on all generators. There are also three sets of holes drilled in the fan 120° apart to be used for the addition of weights when balancing the Diesel engine.

Generators with belt driven auxiliaries require engine balancing weights.

Generators with gear driven auxiliaries do not require engine balancing weights.

1. Make certain there are no bolted weights attached to the weight holes in the generator fan.
2. There are three sets of balancing weight holes, 120° apart but only two sets of these holes are used for bolting engine balancing weights to the fan at any time.

3. Remove fan cover plate from left side of generator adapter. Scribe a mark on the flange of the fan opening of generator adapter 23½" from the bottom of the engine mounting pad on generator adapter.
4. Rotate engine clockwise (facing turning gear) until one set of the balancing weight holes in the fan is cut by the line just scribed on the adapter.
5. Using the left bank pointer, read the degrees on turning gear. This figure locates one set of balancing weight holes. Add 120° to the figure for the location of the second set of holes and 240° for the location of the third set of holes.
6. As only one or two of the three sets of holes will require weights, the following table lists the weights required at different crankshaft settings. Select the pair on the table nearest to the actual reading taken and apply the weights as listed on the table at the degrees designated.

| Location of Holes | | | Wt. Oz. | Location of Holes | | | Wt. Oz. |
|---|---|---|---|---|---|---|---|
| 0° | | 7½° | 14 | 330° | | 37½° | 16 |
| & | or | & | | & | or | & | |
| 120° | | 247½° | 0 | 90° | | 277½° | 8 |
| 352½° | | 15° | 16 | 322½° | | 45° | 16 |
| & | or | & | | & | or | & | |
| 112½° | | 255° | 0 | 82½° | | 285° | 12 |
| 345° | | 22½° | 16 | 315° | | 52½° | 16 |
| & | or | & | | & | or | & | |
| 105° | | 262½° | 6 | 75° | | 292½° | 12 |
| 337½° | | 30° | 16 | 307½° | | 60° | 14 |
| & | or | & | | & | or | & | |
| 97½° | | 270° | 8 | 67½° | | 300° | 14 |

## Example

If the set of holes cut by the scribe mark on the fan opening of the generator adapter is at 28° on the turning gear as indicated by the left bank pointer, the second set will be at 148° (28° + 120°) and the third set will be at 268° (28° + 240°). The balancing weight holes have now been located at 28°, 148° and 268°. Using the table, the pair nearest to these figures are 30° and 270° and require the addition of a 16 oz. weight at the 30° set of holes and an 8 oz. weight at the 270° set of holes. Therefore add a 16 oz. weight to any of the four holes located at 28° and an 8 oz. weight to any of four holes located at 268°. The weights applied should consist of the total included weight of plate, bolts, washers and nuts.

## CYLINDER LINER WEAR

Cylinder liner wear is measured by taking micrometer measurements of the liner bore in a plane perpendicular to the crankshaft at points 1/2" from the top of the liner and 1/4" below the upper end of the piston ring travel. Carefully clean carbon deposits before taking micrometer readings. If the difference between these figures exceed .008", the liner should be returned to the manufacturer for replating.

Repeat this procedure in a plane parallel to the crankshaft following the same instructions.

## MAIN BEARING INSTALLATION

1. Clean and oil main journal and upper bearing shell.

2. Enter the upper shell into the space between the main journal and saddle in such a manner that the lock recess will be on the right side of the engine when the bearing shell is in its normal operating position.

3. Insert bearing removal tool in journal oil hole and turn the crankshaft slowly until the tool contacts the shell. Continue turning the crankshaft making sure not to spring the shell by allowing the tool to force itself between the journal and shell. It may be necessary to hold the shell against the journal for this operation.

4. In order to position the upper shell so that the locking recess will enter the lock on the main bearing cap, place a shell locating tool on the right main bearing stud. Raise it up until the dowel enters the dowel hole and the tongue enters the groove. Shift the upper bearing shell until the lock recess of the shell enters the lock on the tool and then remove the tool.

5. Place the lower bearing shell in the cap, oil and apply.

## MAIN BEARING TIGHTENING

The following instructions should be adhered to when tightening main bearings:

1. Lubricate all faces, seats and threads with engine lubricating oil.

2. Tighten all nuts evenly to about 100 ft. lbs. torque (one man on a two foot wrench).

3. Loosen one nut, measure overall free length of the bolt and tighten until bolt elongation is .015", using dial indicator. Continue tightening until the cotter pin hole is reached.

4. Tighten the remaining nuts in the same manner.

## MAIN BEARING BREAK-IN

Inspect bearings for excessive temperatures after running engine for: -

2 min. at idle
5 min. at idle
15 min. at idle
30 min. in Notch 1
30 min. in Notch 2
30 min. in Notch 3
30 min. in Notch 4

## LOAD TESTING

After overhaul of locomotive or for adjusting HP output the following instructions should be observed.

### I. Insulation Resistance and High Potential Test

Before connecting generator to water box or load resistors the insulation resistance should be checked and a high potential test given as follows:

### A. Insulation Resistance

1. Measure the insulation resistance in megohms of the complete main power circuit.

2. Measure the insulation resistance in megohms of the complete control circuit.

   The insulation resistance for both the main and control circuits should be at least one (1) megohm or more before giving the high potential test.

### B. High Potential Test

#### 1. Main Power Circuit

a. Connect one side of the high potential transformer to the locomotive frame and the other side to the main generator armature circuit.

b. The reverser should be in forward or reverse position and the braking switch (if furnished) in the motoring position.

c. Include the braking resistors and blower motor by connecting all points on the front of the braking switch by copper binding wire or "alligator" clips and flexible wire jumpers.

d. New locomotive - apply 3000 volts for one minute.

e. Locomotive in service.
The Interstate Commerce Commission in the Rules for Testing Locomotives other than Steam makes the following requirements:

> "Not less than once every year an insulation dielectric test of not less than one minute duration shall be applied to all circuits and parts carrying current with potential of more than 150 volts. The voltage applied to circuits other than motor or generator windings, shall not be less than 75 percent above the normal working voltage; the voltage applied to winding shall be not less than 50% above the normal working voltage. A careful examination shall be made of any weakness indicated and all defects remedied before the locomotive is put in use."

On Alco-GE Diesel-Electric Locomotives this test voltage should be not less than 1000 volts applied to the main generator-traction motor circuit only.

f. When high potential testing the main power circuit the auxiliary and control circuits should be grounded to the locomotive frame with a jumper. This will protect these low voltage circuits from high voltage should there be a short circuit from the main power to the auxiliary circuit.

2. Auxiliary wiring and control circuits

   a. All wiring and terminal boards should be looked over tightening any loose connections and correcting any faulty insulation. Disconnect the battery leads in the battery compartment and then close the battery switch.

   b. Connect together the moveable contacts on the GS1 and GS2 contactors.

   c. On TB 3 terminal board (back of compartment) connect points 56 or 57 to 50A.

   d. All switches, breakers, light and heater rheostats on the control compartment, control stand and engine control panel should be "ON".

   e. Engine control switch should be in "Run" position.

   f. Radiator fan control should be "ON" (GE) or Manual #4 (M-H) position.

   g. All plugs on governor, fuel pump, 400 cycle set, engine control panel and in control compartment should be in place.

   h. Apply 680 volts (AC) to the control and auxiliary power circuit with the hi-potential transformer connected to the moveable contact on the GS1 or GS2 contactor and the other connection to the locomotive frame.

   i. Remove all hi-potential wires or jumpers and restore all circuits to normal.

   j. Reconnect battery leads.

## II. Check of Alarm System and Contactor Sequence

A. Close signal relay SR in engine control panel by hand. Alarm bell and buzzer in cab should operate.

B. Close wheel slip relay (WS1) by hand. Wheel slip buzzer in cab should operate and wheel slip light should light. Repeat with WS2. The same effect should be obtained.

C. Block engine temperature switch ETS on engine control panel closed. Alarm bell and alarm buzzer should operate, red engine temperature light should light on engine panel and in cab and OPR deenergized.

D. Open OPS1. Alarm bell should ring and low oil light should light.

E. Close ground relay in control compartment by hand. Alarm bell and alarm buzzer should operate, and "ground relay tripped" light on engine control panel should light.

F. Press the Attendant Call button in cab. Alarm bell and alarm buzzer should operate.

G. Close Fuel Pump switch on engine control panel. Fuel pump contactor FPC in control compartment should pick up. Do not run fuel pump dry.

H. Close MG set breaker on control compartment panel. 400 cycle motor alternator set should run.

I. Close crankcase exhauster breaker on control compartment panel. Crankcase exhauster motor should run.

A check should be made before load testing the locomotive to determine if the contactors are operating in the proper sequence.

J. Close battery switch

Block open GS1 and GS2 with wooden blocks.

The following switches and breakers should be "ON":

(1) Contactor compartment panel: control positive and negative and fuel pump breaker.

(2) Control stand: fuel pump breaker, generator field circuit breaker and control breaker.

(3) Engine Panel: fuel pump switch, engine control knob in "run".

(4) OPS1 and OPS2 should be blocked to prevent alarm bell from ringing.

K. 1500 HP Locomotive Without Automatic Transition

Reverse handle in forward or reverse.

Selector handle in 1
Throttle handle in 1
TDR, S1, S21, GF and EF should pick up.

Selector handle in 2
Same as selector handle in 1
Also, M1 followed by M2, M3 and M4 should pick up.

Selector handle in 3
TR picks up dropping M contactors. S1 and S21 drop picking up P1-P21-P2 and P22. GF and EF will open momentarily and reclose after transfer is completed.

Selector handle in 4
Same as selector handle in 3 except M contactors also pick up.

L. 1500 HP Locomotive With Automatic Transition

Reverse handle in forward or reverse: selector handle in 4 and throttle handle in 1. TDR, S1, S21, GF and EF should pick up.

Block in CR1, TDR, S1, S21, GF, EF, M1, M2, M3 and M4 should pick up.

Block in CR2, drop CR1, TD and TDR picks up; M contactors drop out; P1, P21, P2, P22 pick up; S1 and S21 drop out.

Block in CR3, TDR, TR, P1, P21, P2, P22, GF, EF, M1, M2, M3 and M4 should pick up.

M. 2000 HP Locomotive With Shunter

Reverse handle in forward or reverse; selector handle in 4 and throttle handle in 1. For shunter operation 400 cycle MG set breaker must be "ON". TDR, S1, S21, GF and EF should pick up.

Block in CR1 - Shunter should wind up 17 steps with time delay.

Block in CR2 - Shunter should wind down 17 steps without time delay, and transfer to parallel motoring i.e. pick up P1, P21, P2, P22 and drop out S1 and S21.

Block in CR3 - Shunter should wind up 17 steps with time delay.

N. Take notches No. 2 to 8 on (throttle handle) and see that AVS, BVS, CVS and DVS on engine panel and AVF and CVF in 17LE34 panel pick up per sequence table on wiring schematic diagram and that nothing else changes position.

O. Shut off TH, and see that EF drops immediately, and TDR, S1, and S21 drop in about 1/2 second.

III. Check Dry Run on Governor

A. Check all safety devices.

1. With EC in idle and fuel pump running close engine start switch. (Be sure that contactors GS1 and GS2 are still blocked.) After fuel racks have come out manually close relay SAR and open engine start switch. Now drop out SAR and the fuel racks should return to the shut down position.

2. Close engine start switch; hold in SAR, open start switch. Now turn EC switch to "OFF" position. Fuel racks should return to shut down position.

3. Close engine start switch, close SAR, open start switch. Fuel racks should be in idle position. Now open fuel pump switch and fuel racks should return to shut down position.

4. Close engine start switch, close SAR, open start switch. Fuel racks should be in idle position. Now open oil pressure switch OPS1 and the fuel racks should return to shut down position.

5. Close engine start switch, close SAR, open start switch. Fuel racks should be in idle position. Now pull out engine overspeed reset button and fuel racks should return to shut down position.

6. Close engine start switch, close SAR, open start switch. Fuel racks should be in idle position. Now push emergency stop button in cab and fuel racks should return to shut off position. Turn EC off to drop ESR.

B. Check Fuel Rack Readings

1. Close engine start switch, close SAR, open start switch. Fuel racks are in their idle position. On all engines equipped with 9 hole, .375 nozzles this reading should be about 14 MM. For full rack travel turn EC switch to Run position and put throttle handle in notch 8. Manually depress fuel limit pilot valve. The arm of the fuel limit rheostat on the governor should now be all the way to the end of the active section (commutator) in a counterclockwise direction. If not, loosen the arm and set to end of active section in a counterclockwise direction. The fuel racks are now as far out as the governor will allow them due to the fuel limit cam. Full rack travel should be 24 MM. If these readings are not obtained then adjust fuel control linkage to obtain them. This adjustment will normally be made at the individuel fuel injection pumps. The shut down position of fuel racks may be read by turning EC switch to OFF and dropping out SAR. This reading should be 3 to 4 MM. Turn off fuel pump and return throttle to idle.

IV. Connections for Load Test

A. Disconnect cables from negative side of main generator (GAA) and connect two 2300/24 cables from negative side of water box or load resistor to negative terminal of main generator. Connect two 2300/24 cables from positive side of water box or load resistor to main generator positive terminal plate on back side of control compartment. (For 2000 HP locomotives connect three 2300/24 cables). All other connections may be left on the main generator positive terminal plate. In control compartment disconnect wire #36 from GAA and with a nut and bolt splice run a wire of a size no less than 37/24 to connect to the negative side of main generator to the same terminal as negative water box or load resistor leads. For exhaust temperature connect a thermocouple in exhaust manifold just ahead of turbosupercharger.

B. An engine check should now be made for water, lube oil, generator gear box oil, radiator fan gear box oil and all blocks used in sequence test should be removed (OPS1-OPS2-GS1-GS2).

C. Before starting engine, with EC switch in idle, and fuel pump switch OFF, crank engine over and look at engine RPM indicator to see if it is registering engine speed. There must be an indication before attempting to start engine. This is done to check the tachometer generator.

V. Start the fuel pump and then start engine.

A. Engine break-in (required only after a major overhaul.

B. If engine has already been broken in proceed as follows:

With engine idling check radiator fan for rotation by operating fan manually. (Both Minneapolis

Honeywell and General Electric temperature control units have manual control and they are located in engine panel.) Close auxiliary generator, traction motor blower generator and M.G.set breakers.

C. The locomotive is now ready for loading and the engine can be notched up to the third or fourth notch to warm up the engine and electrical equipment. After engine has warmed up to approximately 150°F, the engine speeds may be set starting with notch 1. The engine speed setting resistors 132 to 132G are located in the engine control panel and are labeled for each particular notch.

Notch 8 - 1000 RPM
Notch 7 - 920 RPM
Notch 6 - 860 RPM
Notch 5 - 765 RPM
Notch 4 - 655 RPM
Notch 3 - 550 RPM
Notch 2 - 450 RPM
Notch 1 - 350 RPM

With engine running in notch 8 and fan off (manual control) and air compressor unloaded, check horsepower output of engine.

This can be done by noting the generator terminal voltage at currents between 2000 and 3000 amperes on the 2000 HP and 1500 to 2000 amperes on the 1500 HP and calculating horsepower by formula:

$$HP = \frac{E \times I}{700}$$

E = Terminal volts
I = Amperes generator current

and should be 1500 or slightly more for the 1500 HP locomotive and 2000 or slightly more for the 2000 HP locomotive.

Refer to generator characteristic curves, figure 8-8 (1500 HP), figure 9-8 (2000 HP). While running at 1000 RPM check tachometer generator voltage. This is 125 to 130 d-c volts across rectifier 133 in engine panel. Adjust auxiliary voltage to 74 volts at idle and full engine speed at the voltage regulator. Check voltage of traction motor blower generator. This should be 140-146 volts and if necessary make adjustment at resistor 113 between wires 74 and 74C in control compartment.

D. Check M.G. set A-C voltage for 115 plus or minus 5 volts. If necessary make adjustment at resistor 122A in excitation panel in control compartment.

E. Throttle Position Loading

In notch 5, the horsepower and rack readings (fuel limit) should be adjusted at fuel limit resistor 161 for notches 5 and 6 in the engine control panel to obtain the following settings:

1500 - 725 HP @ 18 MM.
2000 - 1000 HP @ 18 MM.

In notch 7, the horsepower and rack readings (fuel limit) should be adjusted at resistor 124 for notches 7 and 8 to obtain:

1500 - 1150 HP @ 21.5 MM.
2000 - 1590 HP @ 21.5 MM.

In notch 8 the horsepower and rack readings should be:

1500 - 1500 HP @ 24 MM.
2000 - 2000 HP @ 24 MM.

Adjust the 3rd and 4th notches using resistor 124A. In notch 3 the horsepower and rack readings should be:

1500 - 300 HP @ 15 MM.
2000 - 400 HP @ 14.5 MM.

F. Place motor cutout switch in cutout position and adjust rheostat 130 in engine control panel to obtain approximately 1000 HP for 1500 HP locomotives and 1300 HP for 2000 HP locomotives in eighth notch. To increase HP turn rheostat 130 to left; to decrease turn to right. Check switch by throwing it to other cutout position and running engine in eighth notch.

## VI. Eighth Notch Power Curve: Fig. 8-8 (1500 HP) and Fig. 9-8 (2000 HP)

Starting with maximum amount of current take a voltage reading and for each 100 amperes down to 0 take a voltage reading.

## VII. Current Limit Settings

### A. Current Limit

With engine in eighth notch slowly increase load current to determine if current limit is operating. A resistance of about .022 ohms capable of carrying 2700 amperes (1500 HP) or 3800 amperes (2000 HP) should be placed across the generator terminals and a 1500 milliammeter placed in F1-F2 of the amplidyne (42C wire in control compartment). With selector handle in position 3 and throttle in notch 1 read F1-F2 field circuit current and generator load current. This point must fall within the band shown in figure 2-8 (1500 HP) and 5-8 (2000 HP) limit setting curves. If test point does not fall within band, move slider on resistor 153 in 17LE34 panel until point falls in center of band, increasing resistance to raise main generator current.

With selector handle in position 3, take notch 8, read F1-F2 milliamperes and generator current. This point must fall within the band shown in figure 3-8 (1500 HP) or 6-8 (2000 HP) on curves. If test point does not fall in center of band, decrease resistance "119" to raise current. On 1500 H.P. locomotives there are two different eighth notch current limit values. After a set of readings from eighth notch to first notch have been taken in SH-3 another set must be taken in SH-1. There is no adjustment necessary for this SH-1 set of readings. On 2000 HP locomotives eighth notch current limit is the same in SH-3 as it is in SH-1.

### B. Field Limit:

After the .022 ohm resistance has been removed and a 100 ampere shunt and meter have been put in A1 circuit of the amplidyne (make connections at the amplidyne generator) the generator field current limit is ready to be set. Open main generator load circuit. In notch 8 read F1-F2 milliamperes and generator field current. This point must fall within the band shown in figure 4-8 (1500 HP) or 7-8 (2000 HP) curves. If test point does not fall within the band, move slider on resistor 154 in 17FM64 panel in control compartment until point falls in center of band, decreasing resistance to raise current. Remove meters from circuits.

On 2000 HP locomotives instead of an open circuit a main generator load of 1800-1900 amperes is put on the generator. Otherwise everything is the same as a 1500 locomotive setting.

### C. Braking Current Limit:

1. With generator circuit open and engine idling connect a 5-volt D-C voltmeter with positive connection to P1 contactor and negative to wire #29. Move selector handle to first B in braking position. Reading on voltmeter should be 0 to 0.5 volts. Adjustment is made at resistor 165 in 17FM64 panel in control compartment. This is the minimum braking setting and is based on the

requirement that a minimum motor field current in braking be had at the point at which the selector handle moves into the braking notch from the off position.

2. Set maximum braking by moving lead of voltmeter to wire 36 on ground relay cutout switch and moving selector to full braking. On 1500 HP locomotives this voltage should be about 1.20 volts. On 2000 HP locomotives this voltage should be 1.165 volts. Change this voltage by adjusting resistor 165A in 17FM64 panel in control compartment.

## VIII. Engine Overspeed Test:

Check overspeed switch by running engine in eighth notch and turning rheostat 132H to right until overspeed trips, noting speed at which it trips. This speed should be 1100-1120 RPM. If overspeed switch does not trip by the time engine reaches 1120 RPM shut engine down and make adjustment at the flyball spring in overspeed mechanism. Move sleeve nut in a clockwise direction to lower trip speed. After test has been made turn rheostat 132H all the way to the left.

## IX. Multipoint Shunter (2000 HP locomotives only)

### A. Setting Shunter Relay

The shunter should be set as follows using a potentiometer:

| | Millivolts across FM-86 Terminals #38 and 39 | |
|---|---|---|
| | Pick Up | Pick Up & Drop Must be Within |
| Parallel Settings | CSU 69 min. | 69 to 71 |
| (parallel set rheostat) | CSD 75 max. | 73 to 75 |
| Series Settings | CSU 63 min. | 63 to 65 |
| | CSD 69 max. | 67 to 69 |

The #38 wire to the positive relay terminal should be removed and connected to the negative side of the potentiometer; the positive side of the potentiometer should be connected to the relay plus terminal.

### B. Checking Shunter Connections, Fig. 10-8

1. Instrument - Use a General Electric Company Portable Bridge Catalog 5927123G or equivalent. On the General Electric instrument, scales X1 and X.2 should be used.

2. The four heavy leads between the front of the shunter and reverser should be disconnected at the shunter at points 1, 2, 3 and 4 as shown on Fig. 10-8.

3. The shunter shunting resistor connections for No. 1, 2, 3 and 4 motors are indicated on Fig. 10-8 at 1, 2, 3 and 4 respectively, the connection always being made to any one of the six sherardized cap screws connected to the vertical bus bar.

4. The connection to the other side of the shunter shunting resistor for No. 1, 2, 3 or 4 motors is indicated on Fig. 10-8 as 1, 2, 3 or 4 respectively at the reverser, the connection being on the left side of the reverser at the back side. The cover plate on the control compartment wall (engineer's side near the floor) must be removed to gain access to these connections.

5. One side of the bridge should be connected to points 1, 2, 3 or 4 in the shunter and the other side to points 1, 2, 3 or 4 at the reverser respectively. The reverser should be in neutral.

6. The use of the bridge and this method of connection will very accurately check the resistance value of the 6 resistance elements of the shunting resistor bank and also the resistance in the circuit for the 21 steps in the shunter which is 21 combinations of the forementioned 6 resistance elements. A check also is obtained of the wiring of the circuits between the reverser, shunter and shunter resistor elements and whether or not the included terminals have been properly applied. The two leads on one side of the bridge should have terminals applied which can be connected by the cap screws at the shunter. The two leads on the other side of the bridge should be connected to a large alligator clip which can conveniently be applied to the reverser terminals.

The shunter finger sequence is given below:

| Step | Contacts Closed | Step | Contacts Closed |
|---|---|---|---|
| 1 | 1 | 10 | 1, 2, 3, 5 |
| 2 | 2 | 11 | 1, 2, 4, 5 |
| 3 | 1, 2 | 12 | 1, 3, 4, 5 |
| 4 | 1, 3 | 13 | 1, 2, 3, 4, 5 |
| 5 | 2, 3 | 14 | 1, 2, 3, 5, 6 |
| 6 | 1, 2, 3 | 15 | 1, 2, 4, 5, 6 |
| 7 | 1, 2, 4 | 16 | 1, 3, 4, 5, 6 |
| 8 | 1, 3, 4 | 17 | 1, 2, 3, 4, 5, 6 |
| 9 | 1, 2, 3, 4 | | |

7. The following figures represent averages of the resistance found in the various steps and should be matched quite closely in ohms:

1 - .146
2 - .063
3 - .044
4 - .032
5 - .025
6 - .021
7 - .0169
8 - .0150
9 - .0121
10 - .0108
11 - .0095
12 - .0088
13 - .0078
14 - .0069
15 - .0063
16 - .0062
17 - .0056

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The shunter should be operated by hand by means of a wrench applied to the square top end of the shunter shaft.

8. The resistance values for the 6 resistance elements in the 4 motor circuits (i.e., between the reverser connections and the six K connections on the shunter) should be approximately as follows in ohms (cold):

1 - .146

2 - .066

3 - .043

4 - .025

5 - .022

6 - .017

Add 6% for the resistor hot condition.

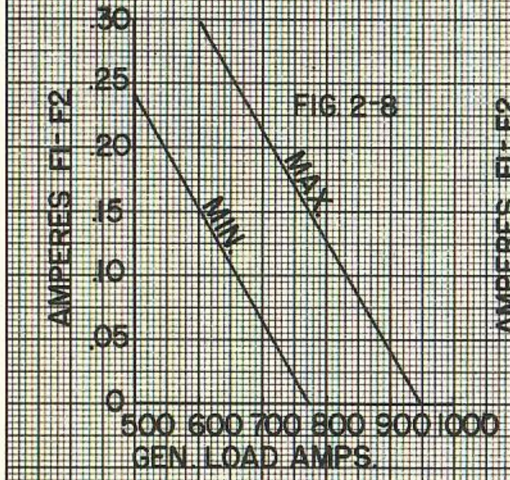
9. The six shunter resistance elements can be checked by connecting one side of the bridge to each of the six K connections on the shunter for each of the four motors and the other side of the bridge to the corresponding motor connection at the reverser (1, 2, 3 or 4).

## X. Setting of Transition, Overspeed Warning and Trip Relays.

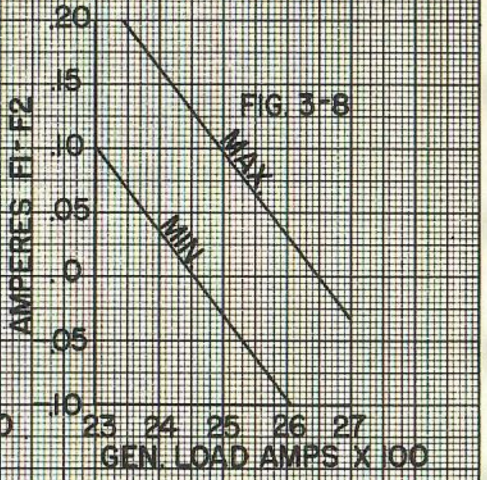
These relays, if used, are located in the control stand and should be adjusted to the settings shown on the accompanying table.

## LIMIT SETTINGS

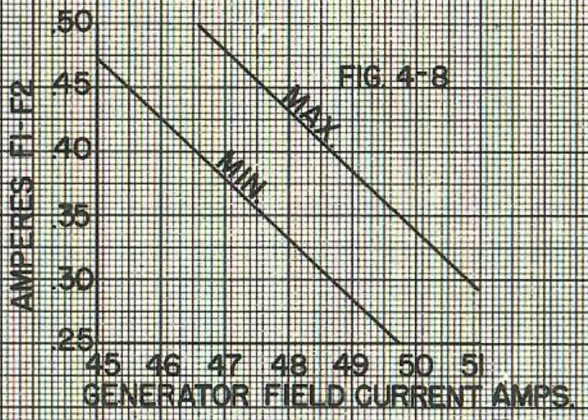
## ALCO-GE 1500 H.P.



FIRST NOTCH CURRENT LIMIT.



EIGHTH NOTCH CURRENT LIMIT.



EIGHTH NOTCH FIELD LIMIT.

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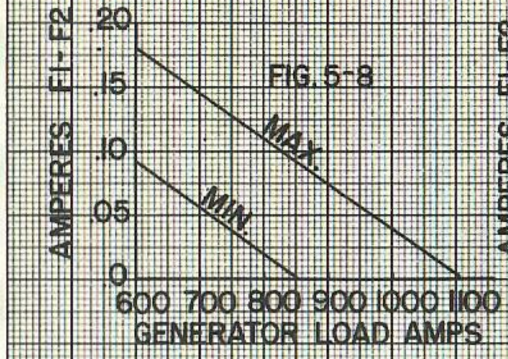
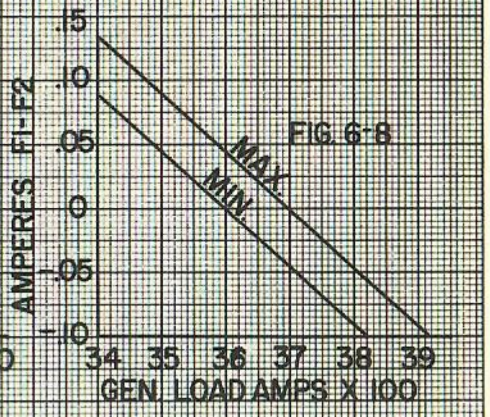
## LIMIT SETTINGS

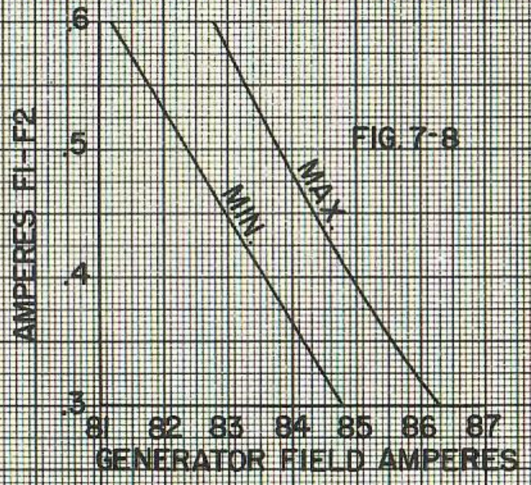
## ALCO-GE 2000HP



FIRST NOTCH CURRENT LIMIT.



EIGHTH NOTCH CURRENT LIMIT



EIGHTH NOTCH GENERATOR FIELD CURRENT LIMIT

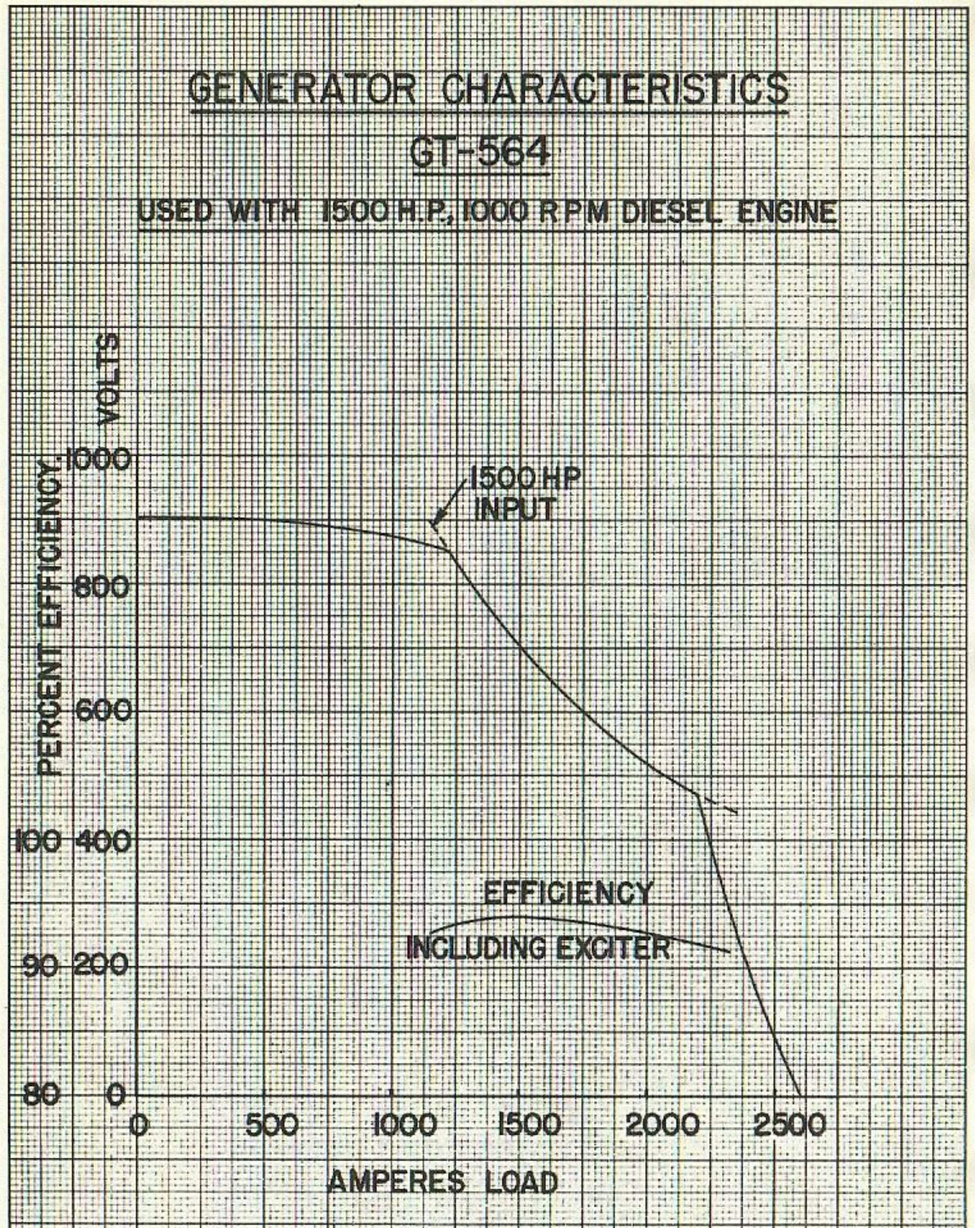

GENERATOR CHARACTERISTICS
GT-564
USED WITH 1500 H.P., 1000 R P M DIESEL ENGINE
PERCENT EFFICIENCY
VOLTS
1000
800
600
100 400
90 200
80 0
1500 HP
INPUT
EFFICIENCY
INCLUDING EXCITER
0
500
1000
1500
2000
2500
AMPERES LOAD

FIG. 8-8

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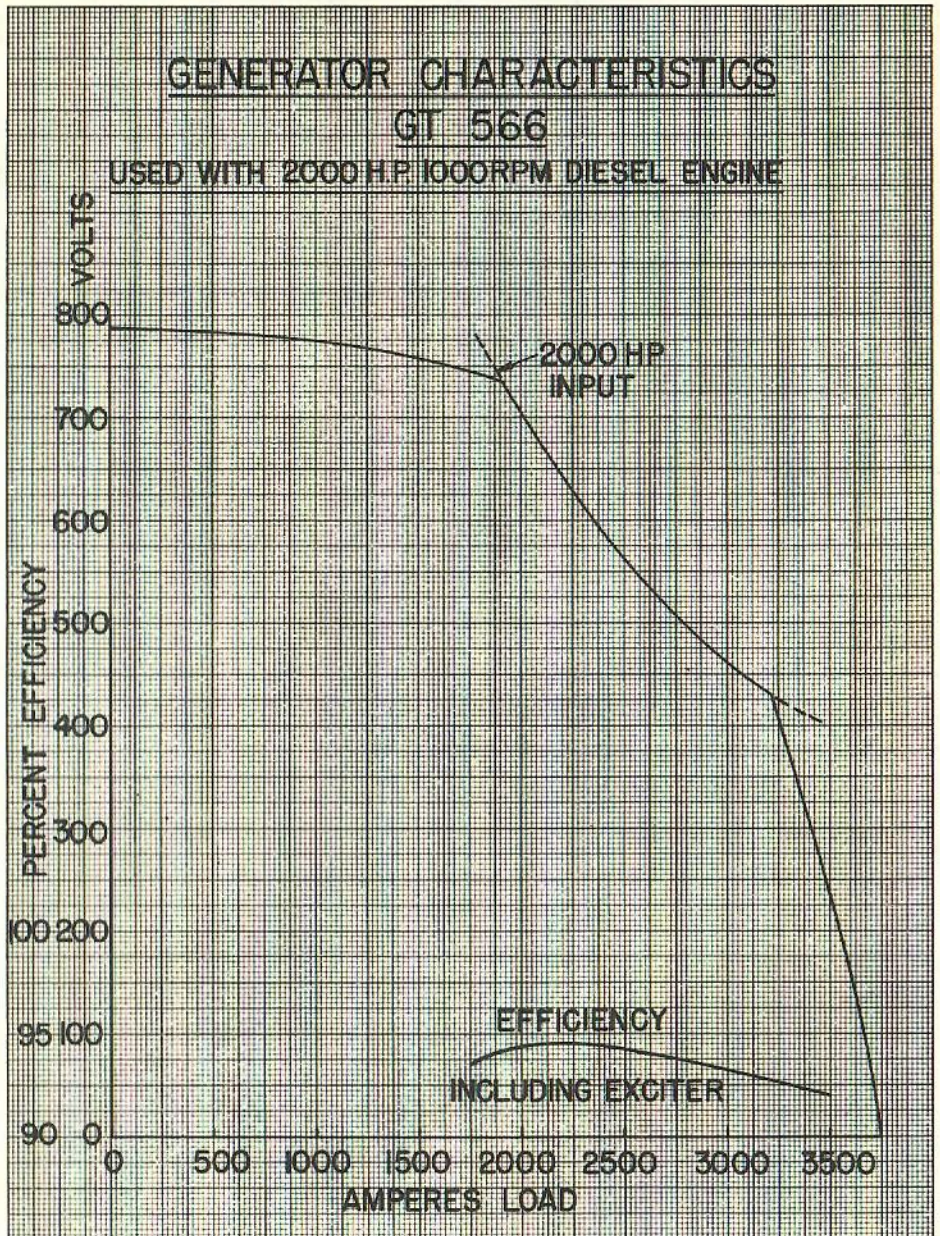
GENERATOR CHARACTERISTICS
GT 566
USED WITH 2000 H.P. 1000 RPM DIESEL ENGINE
VOLTS
PERCENT EFFICIENCY
800
700
600
500
400
300
100 200
95 100
90 0
2000 HP
INPUT
EFFICIENCY
INCLUDING EXCITER
0
500
1000
1500
2000
2500
3000
3500
AMPERES LOAD

FIG. 9-8

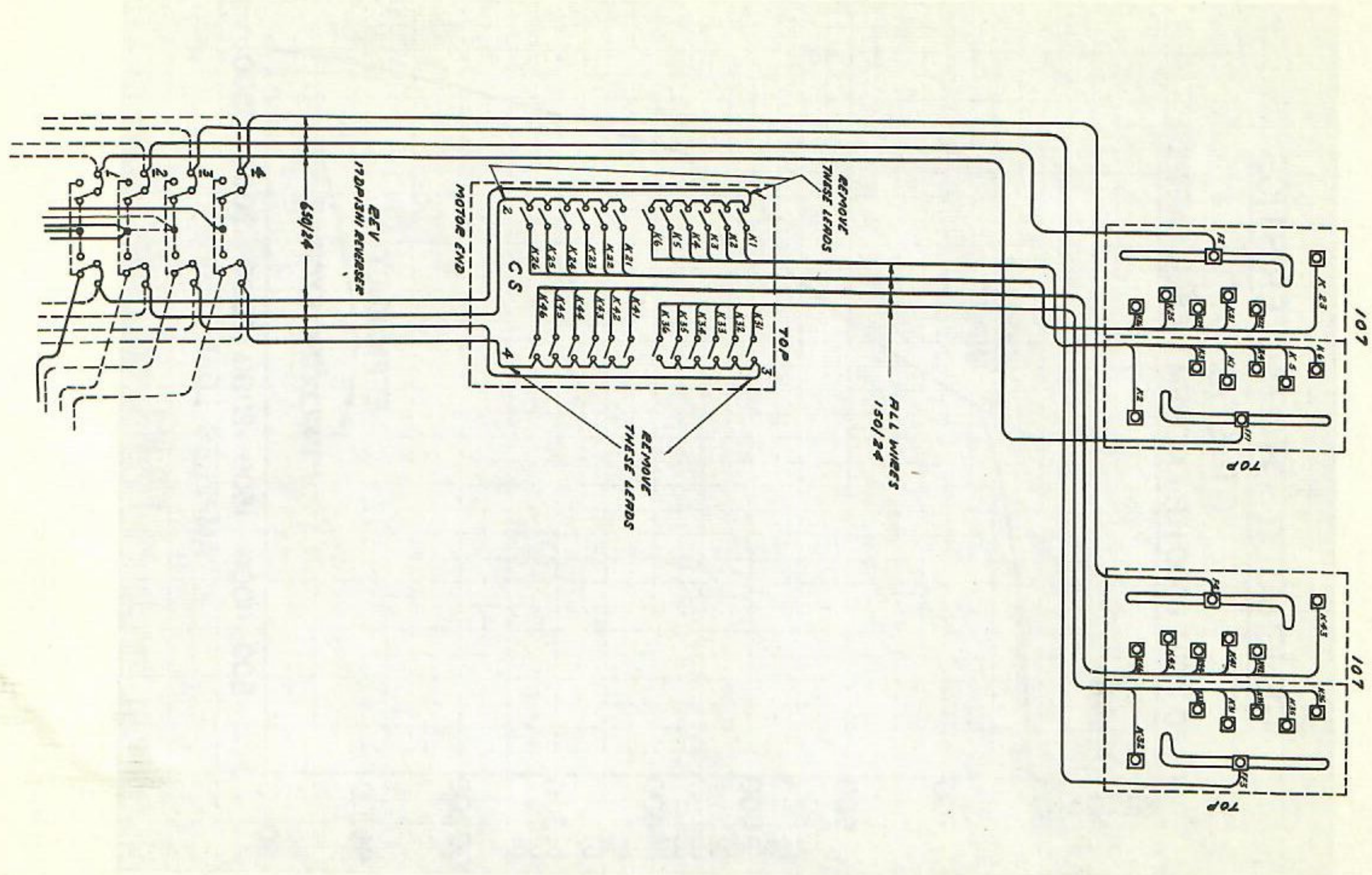
107
107
K 23
K43
TOP
TOP
ALL WIRES 150/24
REMOVE THESE LEADS
REMOVE THESE LEADS
TOP
K1
K2
K3
K4
K5
K6
K31
K32
K33
K34
K35
K36
K21
K22
K23
K24
K25
K26
K41
K42
K43
K44
K45
K46
C S
MOTOR END
REV 17DP13H1 REVERSER
630/24

FIG. 10-8
SHUNTER CONNECTIONS

TRANSITION, OVERSPEED WARNING AND TRIP RELAY SETTINGS

| Railroad Type | 1500 HP Frt. & RS | 1500 HP Frt. & RS | 1500 HP Freight | 2000 HP Passenger | 2000 HP Passenger | 2000 HP Passenger | 2000 HP Passenger | 2000 HP Passenger | 2000 HP Passenger | 2000 HP Passenger | 2000 HP Passenger |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Motor | 752 | 752 | 752 | 746 | 746 | 752 | 752 | 752 | 752 | 752 | 752 |
| Gearing | 74/18 | 65/18 | 74/18 | 64/23 | 64/23 | 61/22 | 62/21 | 64/19 | 62/21 | 60/23 | 58/25 |
| Wheel Dia. | 40" | 40" | 40" | 42" | 42" | 42" | 40" | 40" | 40" | 40" | 40" |
| Top Speed | 65 | 75 | 65 | 101 | 101 | 101 | 91 | 80 | 91 | 104 | 117 |
| Steps Shunt. | 1 | 1 | 1 | 1 | 1 | 17 | 2 | 17 | 17 | 17 | 17 |
| LS1 (CR1)<br>Form<br>MPH<br>RPM | Manual Transition | Manual Transition | 17LE41B6<br>17.0<br>143 | 17LE41A1<br>25<br>200 | 17LE41C4<br>25.5<br>204 | 17LE41B3<br>16.1<br>129 | 17LE41B2<br>19.35<br>162 | 17LE41B3<br>15.3<br>128 | 17LE41B3<br>15.3<br>128 | 17LE41B1<br>17.0<br>143 | 17LE41B2<br>19.35<br>162 |
| LS2 (CR2)<br>Form<br>MPH<br>RPM | | | 17LE41C6<br>23.7<br>199 | 17LE41A2<br>33<br>264 | 17LE41D4<br>32.1<br>257 | 17LE41C11<br>27.3<br>218 | 17LE41C2<br>22.0<br>185 | 17LE41C2<br>22.0<br>185 | 17LE41C3<br>25<br>210 | 17LE41D1<br>28.1<br>236 | 17LE41D5<br>32.4<br>272 |
| LS3 (CR3)<br>Form<br>MPH<br>RPM | | | 17LE41E1<br>49.0<br>411 | 17LE41A3<br>63<br>504 | 17LE41E9<br>64<br>512 | 17LE41D2<br>45.8<br>366 | 17LE41E1<br>49<br>411 | 17LE41D8<br>38.3<br>321 | 17LE41D2<br>43.6<br>366 | 17LE41E1<br>49.0<br>411 | 17LE41E2<br>55.3<br>464 |
| LS4 (CR4)<br>Form<br>MPH<br>RPM | | | | | | | 17LE41E5<br>61<br>511 | | | | |
| LS4 (LOS-DMR)<br>Form<br>Warn. MPH<br>Warn. RPM<br>Trip MPH<br>Trip RPM | 17LE40A2<br><br><br>65<br>546 | 17LE40A1<br><br><br>75<br>630 | 17LE41H4<br>62.0<br>521<br>65<br>546 | 17LE41A4<br>96<br>768<br>101<br>808 | 17LE41F5<br>96<br>768<br>101<br>808 | 17LE51A1 | 17LE41F2<br>86<br>721<br>91<br>762 | 17LE41F1<br>75<br>629<br>80<br>670 | 17LE41F8<br>86<br>721<br>91<br>762 | 17LE41F3<br>99<br>830<br>104<br>872 | 17LE41F4<br>112<br>940<br>117<br>980 |

**ASSEMBLING STEEL TUBING FITTINGS** (Ermeto)

It is recommended that the following instructions be adhered to in order that the correct feel of tightness be obtained from practice to insure a tight steel tubing fitting (Ermeto) on the job.

1. Slide nut and then sleeve on tube making sure collar of sleeve is towards nut.
2. Place fitting in vise and lubricate threads and sleeve seat.
3. Insert tube in fitting making sure tube is bottomed on fitting shoulder.
4. Turn nut slowly with wrench while turning tube with other hand. When the tube can no longer be turned by hand, stop and note position of wrench.
5. Turn nut one and one-half (1-1/2) additional turns. All assemblies should be this tight.

The performance of this type of fitting is not affected if the sleeve can be rotated on the tube.

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# INSPECTION AND LUBRICATION

The following inspection and lubrication instructions supersede Maintenance Inspection Period Bulletin TI-1 and all Lubrication Charts.

Maintenance work is facilitated by work sheets listing the items requiring periodic inspection with mileage between inspections most conveniently arranged for the operating conditions of the particular locomotive.

A general listing of inspection periods will not exactly fit each service rendered by a locomotive, nor will the mileages selected be most conveniently arranged for a particular run. However, the periods selected are representative of average results obtained in service and can be used in preparing work sheets for any particular operation.

Periodic lubrication and inspection of all points should be carefully followed.

The Interstate Commerce Commission "Laws, Rules and Instructions for Inspection and Testing of Locomotives Other Than Steam" should be strictly adhered to along with the work listed. ICC inspection forms should be followed and prepared as required.

**THE WORK LISTED UNDER EACH INSPECTION AND LUBRICATION PERIOD IS TO BE REPEATED WHEN THAT MILEAGE INTERVAL RECURS.**

## MAINTENANCE INSPECTION PERIODS
## 1500 H.P. ROAD SWITCHER LOCOMOTIVE
## 1500 H.P. FREIGHT LOCOMOTIVE

### MECHANICAL - Daily or Trip

1. Check work report, also locomotive for defects (ICC).
2. See that all seals are intact.
3. Fuel Oil System
    - a. Inspect tanks and piping for leaks (ICC).
    - b. Inspect tank gauge.
    - c. Inspect remote gauge if used.
    - d. Refuel
4. Cooling Water System
    - a. Add water if necessary together with treatment to bring sight glass to 3/4 level.
    - b. Check system for leaks.
    - c. Check water pump telltale hole for oil or water leakage. Do not plug.
    - d. Test water for proper treatment.
5. Test sanders and refill boxes as necessary.
6. Air brake equipment test and inspection (ICC).
    - a. Inspect brake shoes and renew as necessary.
    - b. Check piston travel; equalize.
    - c. Test functioning of brakes and deadman control.
    - d. Check air compressor, pressures and governor.
    - e. Drain condensation from main and control air reservoirs, air compressor intercooler and automatic shutter control air filters.
7. Test operation of bell ringer, horn and windshield wipers.
8. Test operation of radiator shutters and fan.
9. Maintain all fire extinguishers in proper operating condition.
10. Clean locomotive and eliminate any fire hazard.
11. Test operation of power control switch (if used).
12. Check locomotive supplies and equipment, fusees, torpedoes, flagging equipment, spare bulbs, tool box.

### MECHANICAL - Daily or Trip (cont'd)

13. Examine turbosupercharger air filters to determine whether cleaning is necessary; also locomotive panel filters (freight only).
14. Clean and disinfect toilets and fill toilet water tanks (freight only).
15. Inspect traction motor air ducts for defects.
16. Make crankcase inspection with engine shut down.
17. Note all gauges for correct operating pressures and temperatures.
18. Inspect upper and lower fan drive universal joints.
19. Inspect running gear, trucks, wheels, foundation brakes and related parts.
20. Inspect belts on all belt driven auxiliaries.

### ELECTRICAL - Daily or Trip

1. Read specific gravity of battery pilot cell. Add water to all cells if necessary.
2. Check battery charging voltage. Make sure voltage regulator is off current limit.
3. Test headlight, cab, engine room and rear lights; also Mars headlight (if used).
4. When units are in multiple, inspect application of electrical control jumpers.
5. Make sequence test, both forward and reverse, from each operating cab with units coupled together.
6. Check and inspect operation of cooling fan control.
7. Inspect commutator and brushes on:
    - Traction motors
    - Traction generator
    - Auxiliary generators
    - Traction motor blower motors (freight only)
    - Amplidyne exciter
    - Eddy-current clutch
8. Check fuel-governor pump motor operation and fuel pressure.
9. Make external inspection of all electrical rotating machinery for unusual noise, heat or odor while engine is running.
10. Check crankcase exhauster motor operation.

## ELECTRICAL - Daily or Trip (cont'd)

11. Make visual inspection of governor brush arms and rheostats.
12. See that all seals are intact.
13. Make visual inspection in electrical compartments.
14. Check operation of cab heaters; also defroster (freight only).
15. Check switch position of ground relay cutout switch and motor cutout switch.

## LUBRICATION - Daily or Trip

Refer to Lubrication Schedule.

## MECHANICAL - 3,000 Miles

1. Drain sediment and condensation from fuel oil tank.
2. Inspect valve lever mechanism. Note operation and lubrication with engine running.
3. Check governor and fuel pump rack linkage freedom of movement.
4. Examine lubricating oil filters and repack if necessary. Repack at each oil change.
5. Blow down Minneapolis-Honeywell air filter.
6. Clean lube oil strainer.

## LUBRICATION - 3,000 Miles

Refer to Lubrication Schedule.

## LUBRICATION - 6,000 Miles

Refer to Lubrication Schedule

## MECHANICAL - 12,000 Miles

1. Check operation of emergency fuel cutoff valve.
2. Check fuel pump timing.
3. Check air and exhaust valve clearance.
4. Clean expansion tank sight glass if necessary.
5. Inspect air compressor intercooler fan.
6. Check fuel pump rack travel by making dry run.
7. Inspect both air compressor flexible couplings, bolts and parts.

## MECHANICAL - 12,000 Miles (cont'd)

8. Blow out radiators with compressed air.
9. Check and adjust belt tension as necessary.
10. Check engine speeds on all notches and engine overspeed trip.
11. Inspect dynamic brake discharge air louvres for free operation (if used).
12. Remove inspection plate on engine overspeed trip housing and rotate shaft by hand to determine whether or not the spring drive is in good order.
13. Clean air compressor intake filters.
14. Repack duplex fuel oil suction filter.
15. Clean felt fuel oil discharge filter.
16. Clean governor oil filter and strainer.
17. Clean air compressor breather.
18. Drain condensation from Timken roller bearing box.
19. Clean Minneapolis-Honeywell air strainer.

## ELECTRICAL - 12,000 Miles

1. Wash out battery boxes, tighten and grease terminals.
2. Blow out with dry compressed air the main generator, auxiliary generators, electrical compartment, traction motor blower motors (freight only), etc.
3. Check high and low voltage systems for grounds.
4. Inspect brushes and commutator on fuel booster pump motor.
5. Inspect brushes and commutator on crankcase exhauster motor.
6. Check equipment in electrical compartments for loose connections.
7. Check operation of auxiliary generator voltage regulators. Adjust while hot at specified voltage at both high and low engine speeds.
8. Inspect control jumper cables and receptacles.
9. Clean and inspect electrical equipment on engine governor.
10. Clean and inspect interior of throttle control stand, engine control and control compartment panels.
11. Check operation of all alarm circuits.
12. Make complete sequence test, observing contactor and relay operation.

## ELECTRICAL - 12,000 Miles (cont'd)

13. Inspect dynamic brake blower motor brushes, commutator, connections and grids (if used).
14. Inspect 400 cycle alternator, brushes, commutator and slip rings.

## LUBRICATION - 12,000 Miles

Refer to Lubrication Schedule.

## MECHANICAL - 36,000 Miles

1. Test air gauges (ICC).
2. Test main reservoir safety valves (ICC).
3. Apply orifice test to air compressor (ICC).
4. Apply new diaphragm to deadman pedal (if used).
5. Remove, clean and test fuel injection nozzles.
6. Flush and clean governor oil tank and piping system and check pressure.
7. Flush Diesel engine cooling water system and refill adding the proper amount of Diesel engine cooling water treatment.
8. Inspect and tighten foundation bolts of lube oil filter, cooler, engine, etc.
9. Clean radiator shutter air filter.

## ELECTRICAL - 36,000 Miles

1. Check transition speeds measuring axle generator speed relay pick-up; separately drive axle generator. Also make this check at wheel change.

## LUBRICATION - 36,000 Miles

Refer to Lubrication Schedule.

## MECHANICAL - 72,000 Miles

1. Remove and inspect knuckle pins (ICC).
2. Clean and test air brake equipment (ICC).

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## MECHANICAL - 72,000 Miles (cont'd)

3. Make visual inspection of split crankshaft gear, nuts and bolts through crankcase base door.
4. Remove, clean and inspect air compressor valves.

## LUBRICATION - 72,000 Miles

Refer to Lubrication Schedule.

## MECHANICAL - 120,000 Miles

1. Remove and inspect two pistons to determine general condition of cylinder heads, valves, liner and jacket water passages, liner wear, piston and ring condition, rod, pin, and bearing condition.
2. Surface inspect engine parts removed for inspection, magnafluxing where possible.
3. Clean oil side of lubricating oil cooler, or more often if necessary.
4. Examine traction motor blower fan bearings (road switcher).
5. Inspect all main bearings.
6. Check crankshaft deflection.
7. Inspect traction motor air ducts, side bearings and center bearings during truck removal.
8. Hydrostatic and hammer test main air reservoirs. (ICC)
9. Remove and check oil seal at free end of engine (if used.
10. Remove and dismantle water pump, checking seals and other wearing parts.
11. Remove and inspect water pump drive gear bearing and inspect gear train.
12. Remove tachometer generator and crankcase exhauster housings, inspect gear train and measure camshaft thrust.
13. Inspect tachometer generator drive gear, backlash of bevel gears and thrust. Note condition of tachometer generator drive unit parts.

## MECHANICAL - 120,000 Miles (cont'd)

14. The recommended overhaul period of the RD-1 turbo-supercharger is 300,000 miles or two years (whichever occurs first) with subsequent overhauls every 150,000 miles or annually (whichever occurs first).
15. Thoroughly clean and inspect locomotive frame, deck plates, etc. (ICC).
16. Examine condition and wear of auxiliary drive pulleys on road switcher.
17. Remove and dismantle lubricating oil pump for inspection.
18. Remove and inspect lubricating oil pump drive gear and bearing.
19. Remove and inspect radiator fan and examine key and keyway.
20. Remove and inspect both upper and lower vertical fan shaft bearings.
21. Remove and dismantle radiator fan universal joints and bearings for inspection and replacement of worn parts.
22. Remove fuel injection pumps. Check for leakage and calibration.
23. Remove and dismantle both flexible couplings at air compressor for inspection and replacement of worn parts.
24. Remove and dismantle air compressor for inspection and replacement of worn parts.
25. Remove and inspect automatic sander valves and traps.
26. Overhaul windshield wipers.
27. Overhaul bell ringer.

## ELECTRICAL - 120,000 Miles

1. Remove and dismantle governor for inspection and replacement of worn parts.
2. Remove and clean battery; repaint battery leads; recondition terminals; test by cycling or standard railroad methods.
3. Recondition tachometer generator.
4. Check calibration of voltmeter and ammeters (ICC).

## ELECTRICAL - 120,000 Miles (cont'd)

5. Apply insulation dielectric test (ICC).
6. Overhaul motor-alternator and repack bearings.
7. Overhaul fuel pump motor and replace bearings.
8. Overhaul crankcase exhauster motor and repack bearings.
9. Overhaul cab heater and defroster motors, (freight only), and replace bearings.
10. Overhaul traction motors, checking pinion and axle gear for wear and surface condition. Clean and inspect gear casing.
11. Check amplidyne exciter circuit control adjustments.
12. Check dynamic brake warning relay adjustments (if used).
13. Remove and clean dynamic brake grids and paint housing (if used).
14. Overhaul sander magnet valves and control valve.
15. Overhaul controller.
16. Inspect all electrical equipment in contactor compartment such as electro-pneumatic contactors, relays, reverser, magnetic contactors and braking switch; examine magnet valves, air pistons and bearings for worn parts, replacing as necessary.
17. Examine, clean and repaint all exposed electrical wiring.
18. Overhaul speedometer tachometer generator.
19. Overhaul LOS axle generator (if used).
20. The following items should be inspected and repaired if necessary, to assure another year's operation.
    - Traction generator
    - Auxiliary generators
    - Traction motor blower motors
    - Dynamic brake blower motor (if used)
    - Amplidyne exciter
    - All panels and wiring
    - Eddy-current clutch
    - Radiator fan gear box

## LUBRICATION - 120,000 Miles

Refer to Lubrication Schedule.

## MAINTENANCE INSPECTION PERIODS
## 2000 H.P. PASSENGER LOCOMOTIVE

### MECHANICAL - Daily or Trip

1. Check work report; also locomotive for defects (ICC).
2. See that all seals are intact.
3. Fuel Oil System
    a. Inspect tanks and piping for leaks (ICC).
    b. Inspect tank gauge and remote gauge.
    c. Refuel
4. Cooling Water System
    a. Add water if necessary together with treatment, to bring sight glass to 3/4 level.
    b. Check system for leaks.
    c. Check water pump telltale hole for oil or water leakage. Do not plug.
    d. Test water for proper treatment.
5. Test sanders and refill boxes as necessary.
6. Air brake equipment test and inspection (ICC).
    a. Inspect brake shoes and renew as necessary.
    b. Check piston travel; equalize.
    c. Test functioning of brakes and deadman control.
    d. Check air compressor pressures and governor.
    e. Drain condensation from main and control air reservoirs, air compressor intercooler and automatic shutter control air filters.
7. Test operation of bell ringer, horn and windshield wipers.
8. Test operation of radiator shutters and fan.
9. Maintain all fire extinguishers in proper operating condition.
10. Clean locomotive and eliminate any fire hazard.
11. Test operation of power control switch.
12. Check locomotive supplies and equipment; fusees, torpedoes, flagging equipment, spare bulbs, tool box.
13. Examine turbosupercharger air filters and locomotive panel filters to determine whether cleaning is necessary.

### MECHANICAL - Daily or Trip (cont'd)

14. Clean and disinfect toilets and fill toilet water tanks.
15. Inspect traction motor air ducts for defects.
16. Make crankcase inspection with engine shut down.
17. Note all gauges for correct operating pressures and temperatures.
18. Inspect upper and lower fan drive universal joints.
19. Inspect running gear, trucks, wheels, foundation brakes and related parts.

### ELECTRICAL - Daily or Trip

1. Read specific gravity of battery pilot cell. Add water to all cells if necessary.
2. Check battery charging voltage. Make sure voltage regulator is off current limit.
3. Test headlight, cab, engine room and rear lights; also Mars headlight if used.
4. When units are in multiple, inspect application of electrical control jumpers.
5. Make sequence test, both forward and reverse, from each operating cab with units coupled together.
6. Check and inspect operation of cooling fan control.
7. Inspect commutator and brushes on:
    - Traction motors
    - Traction generator
    - Auxiliary generators
    - Traction motor blower motors
    - Eddy-current clutch
    - Amplidyne exciter
8. Check fuel-governor pump motor operation and fuel pressure.
9. Make external inspection of all electrical rotating machinery for unusual noise, heat or odor while engine is running.
10. Check crankcase exhauster motor operation.
11. Make visual inspection of governor brush arms and rheostats.
12. See that all seals are intact.
13. Make visual inspection in electrical compartments.
14. Check operation of cab heaters and defrosters.

## ELECTRICAL - Daily or Trip (cont'd)

15. Check switch position of ground relay cutout switch and motor cutout switch.

## LUBRICATION - Daily or Trip

Refer to Lubrication Schedule.

## MECHANICAL - 6,000 Miles

1. Drain sediment and condensation from fuel oil tank.
2. Inspect valve lever mechanism. Note operation and lubrication with engine running.
3. Check governor and fuel pump rack linkage freedom of movement.
4. Examine lubricating oil filters and repack if necessary. Repack at each oil change.
5. Blow down Minneapolis-Honeywell air filter.
6. Clean lube oil strainer.

## LUBRICATION - 6,000 Miles

Refer to Lubrication Schedule.

## MECHANICAL - 24,000 Miles

1. Check operation of emergency fuel cutoff valve.
2. Check fuel injection pump timing.
3. Check air and exhaust valve clearance.
4. Clean expansion tank sight glass if necessary.
5. Inspect air compressor inter-cooler fan.
6. Check fuel pump rack travel by making dry run.
7. Inspect both air compressor flexible couplings, bolts and parts.
8. Blow out radiators with compressed air.
9. Check engine speeds on all notches and engine overspeed trip.
10. Inspect dynamic brake discharge air louvres for free operation. (If used)
11. Remove inspection plate on engine overspeed trip housing and rotate shaft by hand to determine whether or not the spring drive is in good order.

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## MECHANICAL - 24,000 Miles (cont'd)

12. Clean air compressor intake filters.
13. Repack duplex fuel oil suction filter.
14. Clean felt fuel oil discharge filter.
15. Clean governor oil filter and strainer.
16. Clean air compressor breather.
17. Drain condensation from Timken roller bearing box.
18. Clean Minneapolis-Honeywell fan control air strainer.

## ELECTRICAL - 24,000 Miles

1. Wash out battery boxes, tighten and grease terminals.
2. Blow out with dry compressed air the main generator, auxiliary generators, electrical compartment, traction motor blower motors, etc.
3. Check high and low voltage systems for grounds.
4. Inspect brushes and commutator on fuel booster pump motor.
5. Inspect brushes and commutator on crankcase exhauster motor.
6. Check equipment in electrical compartments for loose connections.
7. Check operation of auxiliary generator voltage regulator. Adjust while hot at specified voltage at both high and low engine speeds.
8. Clean and inspect electrical equipment on engine governor.
9. Clean and inspect interior of throttle control stand, engine control and control compartment panels.
10. Check operation of all alarm circuits.
11. Make complete sequence test observing contactor, relay and field shunter operation.
12. Inspect dynamic brake blower motor brushes, commutator, connections and grids (if used).
13. Inspect 400 cycle alternator brushes, commutator and slip rings.

## LUBRICATION - 24,000 Miles

Refer to Lubrication Schedule.

## LUBRICATION - 36,000 Miles

Refer to Lubrication Schedule.

## MECHANICAL - 72,000 Miles

1. Test air gauges (ICC).
2. Test main reservoir safety valves (ICC).
3. Apply orifice test to air compressor (ICC).
4. Apply new diaphragm to deadman pedal.
5. Remove, clean and test fuel injection nozzles.
6. Flush and clean governor oil tank and piping system and check pressure.
7. Flush Diesel engine cooling water system and refill, adding the proper amount of Diesel engine cooling water treatment.
8. Inspect and tighten foundation bolts of lube oil filter, cooler, engine, etc.
9. Clean radiator shutter air filter.

## ELECTRICAL - 72,000 Miles

1. Check transition speeds, measuring axle generator speed relay pick-up; separately drive axle generator. Also make this check at wheel change.

## LUBRICATION - 72,000 Miles

Refer to Lubrication Schedule.

## LUBRICATION - 100,000 Miles

Refer to Lubrication Schedule.

## MECHANICAL - 144,000 Miles

1. Remove and inspect knuckles and knuckle pins (ICC).
2. Clean and test air brake equipment (ICC).
3. Make visual inspection of split crankshaft gear, nuts and bolts through crankcase base door.
4. Remove, clean and inspect air compressor valves.

## LUBRICATION - 144,000 Miles

Refer to Lubrication Schedule.

## MECHANICAL - 240,000 Miles

1. Remove and inspect two pistons to determine general condition of cylinder heads, valves, liner and jacket water passages, liner wear, piston and ring condition, rod, pin, and bearing condition.
2. Surface inspect engine parts removed for inspection, magnafluxing where possible.
3. Clean oil side of lubricating oil cooler or more often as required.
4. Inspect all main bearings.
5. Check crankshaft deflection.
6. Inspect traction motor air ducts, side bearings and center bearings during truck removal for defects.
7. Hydrostatic and hammer test main air reservoirs (ICC).
8. Remove and check oil seal at free end of engine (if used).
9. Remove and dismantle water pump, checking seals and other wearing parts.
10. Remove and inspect water pump drive gear bearing; inspect gear train.
11. Remove tachometer generator and crankcase exhauster housings, inspect gear train and measure camshaft thrust.
12. Inspect tachometer generator drive gear, backlash of bevel gears and thrust. Note condition of tachometer generator drive unit parts.
13. The recommended overhaul period of the RD-2 turbosupercharger is 300,000 miles or one year, whichever occurs first; subsequent overhauls on the same basis.
14. Thoroughly clean and inspect locomotive frame, deck plates, etc. (ICC).
15. Remove and dismantle lubricating oil pump for inspection, replacing worn parts if necessary.
16. Remove and inspect lubricating oil pump drive gear and bearing.
17. Remove and inspect radiator fan, and examine key and keyway.

## MECHANICAL - 240,000 Miles (cont'd)

18. Remove and inspect both upper and lower vertical fan shaft bearings.
19. Remove and dismantle radiator fan universal joints and bearings for inspection and replacement of worn parts.
20. Remove fuel injection pumps. Check for leakage and calibration.
21. Remove and dismantle both flexible couplings at air compressor for inspection and replacement of worn parts.
22. Remove and dismantle air compressor for inspection and replacement of worn parts.
23. Remove and inspect automatic sander valves and traps.
24. Overhaul windshield wipers.
25. Overhaul bell ringer.

## ELECTRICAL - 240,000 Miles

1. Overhaul motor-alternator and repack bearings.
2. Overhaul fuel pump motor and replace bearings.
3. Overhaul crankcase exhauster motor and repack bearings.
4. Overhaul cab heater and defroster motors and replace bearings.
5. Overhaul traction motors, checking pinion and axle gear for wear and surface condition. Clean and inspect gear casing.
6. Remove and dismantle governor for inspection and replacement of worn parts.
7. Remove and clean battery; repaint battery leads; recondition terminals; test by cycling or by standard railroad methods.
8. Recondition tachometer generator.
9. Check calibration of voltmeter and ammeters (ICC).
10. Apply insulation dielectric test (ICC).
11. Check amplidyne exciter circuit control adjustments.
12. Check dynamic braking warning relay adjustments if used.
13. Check multipoint shunter control adjustment.

## ELECTRICAL - 240,000 Miles (cont'd)

14. Remove and clean dynamic brake grids and paint housing (if used).
15. Overhaul sander magnet valves and control valve.
16. Overhaul controller.
17. Examine, clean and repaint all exposed electrical wiring.
18. The following items should be inspected and repaired if necessary to assure another year's operation.
    - Traction generator
    - Auxiliary generators
    - Traction motor blower motors
    - Dynamic brake blower motor (if used)
    - Amplidyne exciter
    - All panels and wiring
    - Eddy-current clutch
    - Radiator fan gear box

## LUBRICATION - 240,000 Miles

Refer to Lubrication Schedule.

## MAINTENANCE INSPECTION PERIODS
## STEAM GENERATORS

## VAPOR-CLARKSON TYPE
### OK-4630 and OK-4616
### DRK-4530 and DRK-4516

### Daily or Trip

1. Clean the strainer in the Water Treatment Tank. Fill the tank with water before replacing the cover. Make certain the cover is seated properly and clamped down tightly.

2. Clean the strainers in the water line. On the OK-4630, clean the strainer in the water manifold. There is no strainer on the OK-4616 that corresponds to this one. On the DRK-4530 and DRK-4516, clean the screen of the water strainer.

3. Close the return water outlet valve to shut off the pressure. Then clean the screen in the strainer between the separator and the steam trap. These strainers in the return water line are the "Y" type on the DRK and the square type on the OK.

4. Turn the handle on the Fuel Oil Filter several times.

5. Check the oil level in the water pump crankcase. Add additional oil if necessary. Excessive loss of oil indicates that the pump should be replaced.

   There is an oil level stick on the 1600 pound units for this purpose, but the 3000 pound units have a pet-cock. If oil runs when opened, the oil level is high enough.

6. Empty the drip pan on the 1600 pound unit water pump.

7. If the unit is equipped with an injector water treater, turn the treatment filter handle several times. Check the amount of treatment in the tank. Note that a normal amount of treatment has been used.

8. Remove the peep sight glasses and clean them. While the sight glasses are off, look through the sight glass openings with a flashlight. See that the stabilizing cone and the nozzle have not collected an excessive deposit of carbon.

9. Lubricate the bearings on the blower shaft. Also lubricate damper shaft bearings that are furnished with fittings.

   See that the damper is free to operate.

10. While making the following tests, be sure that the Diesel engine is running in order to keep up the required voltage.

    Place an adapter coupling with the proper orifice on the trainline of the locomotive.

    A 3/4" I.P.S. pipe nipple is used for testing a 3000 pound unit; a 3/8" I.P.S. pipe nipple for the 1600 pound unit.

    If the unit is equipped with a blow-off line, it is not necessary to apply an adapter coupling to the locomotive trainline.

11. Fill the steam generator with water. See that spark is available for ignition.

12. While the motor is running, check the Fuel Manifold Pressure Gauge. It should come up to normal operating pressure almost immediately. Low pressure indicates a leak in the fuel suction line.

13. To test the Outfire Relay, first make certain the

Atomizing Air Admission Valve is closed. Then turn the Control Switch to "run".

The fire should not light. In about 40 to 60 seconds the outfire relay should shut down the generator. The Alarm Bell should ring.

14. Start the steam generator. Set the water by-pass regulator at 250 pounds. Allow the generator to run about five to ten minutes.

15. After the generator has reached a steady output it should develop and maintain a gauge pressure of at least 150 pounds. If it does not, the generator is not delivering its full output.

16. Check the water pressure gauge. If the hand does not hold a steady pressure, but wavers back and forth, the water pump is not delivering its full output.

17. Check the water suction line valves. Make sure all valves that should be opened are opened; that all that should be closed are closed. Check for leaks in the water suction line.

18. If the water pressure exceeds 400 pounds, the coils are becoming scaled and should be washed out.

To make certain that sufficient water is entering the coils, open the water pump test valve. Water should flow from this valve without any evidence of air being pumped. When water flows from this valve, the servo drops to the block, the fire goes out and the cutout switch shuts down the generator. This indicates that the servo fuel control is functioning to shut the fire off in the absence of feed water.

19. Check the condition of the fire. If the spray of the fuel nozzle is distorted or .

If the Nozzle Fuel Pressure is high and insufficient fuel is being burned, the nozzle should be removed and examined.

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If the nozzle tip orifices are out of round or damaged, the nozzle tip should be replaced.

If the nozzle tip is not damaged but just clogged, clean it with a suitable solvent. Use a wooden splinter to clean out the orifices if necessary. Do not use a wire or metal pick for this purpose.

20. See that the water pump packing is not leaking excessively. A slight leak helps to keep the packing lubricated, but excessive leakage should be corrected.

21. See that the Servo-Fuel Control has at least three-quarter travel when the control switch is turned to the "Run" position.

22. While the steam generator is operating at full capacity, see that the Manifold Fuel Pressure, the Nozzle Fuel Pressure and the Atomizing Air Pressure are normal.

The normal operating Fuel Manifold Pressure is about 150 to 155 pounds.

Normal operating Atomizing Air Pressure ranges between 70 and 75 pounds on the 3000 pound units and between 30 and 35 pounds on the 1600 pound units.

23. After the generator has operated long enough and has settled down to a steady output, observe the water flow indicator.

This indicator of the Return Water Flow should cycle from 4 to 12 times a minute on the 3000 pound units. On the 1600 pound units it should cycle 4 to 8 times.

24. Check the generator steam pressure gauge. It should read about the same as the water by-pass regulator setting.

25. Operate the steam generator at full capacity, half capacity and at minimum capacity by throttling with the Manual Water By-pass Valve.

During this throttling with the Manual By-pass Valve the smoke hood cover should not get too hot. The stack gases should be perfectly clear and the stack temperature should not exceed 850 degrees fahrenheit.

26. After completing these tests, unless the locomotive is going directly into service the steam generator should be blown down and the coils refilled with water.

## TABULATED DATA

| | | |
|---|---|---|
| Rated Evaporative Capacity, lbs. water per hour . . . . | 1600 lbs. | 3000 lbs. |
| Water Relief Valve Unloading setting . . . . . . . . . . | 550 lbs. | 550 lbs. |
| Fuel Pressure Regulator set at high fire, to give a manifold pressure of . . . . . | 150-155 lbs. | 150-155 lbs. |
| Atomizing Air Pressure Reducing Valve set at . . . . | 30- 35 lbs. | 70- 75 lbs. |
| Steam Temp. Limit Control set at (approx.) . . . . . . | 450 deg. F. | 450 deg. F. |
| Stack Switch set at . . . . . | 900 deg. F. | 900 deg. F. |
| Outfire Control set to shut down generator after . . . | 40 to 60 sec. | 40 to 60 sec. |
| Motor Speed . . . . . . | 1750 RPM to 1800 RPM | 1750 RPM to 1800 RPM |
| Blower Speed . . . . . . . | 2800 RPM | 2200 RPM |
| Water Pump Speed . . . . . . | 995 RPM | 390 RPM |
| Water Pressure normally varies from low to high fire . . . | 225-350 lbs. | 225-350 lbs. |
| Amperage Draw . . . . . | 30-40 amps. | 50-70 amps. |
| Lowest Steam Evaporation Rate without cycling . . . | 600-800 lbs. | 700-900 lbs. |
| Orifice for Terminal Inspection Test (I.P.S. pipe nipple) . . . | 3/8" | 3/4" |
| Trainline Pressure (terminal inspection test) . . | 150 lbs. | 150 lbs. |

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## 3000 MILE -- FREIGHT SERVICE
## 6000 MILE -- PASSENGER SERVICE

1. IGNITION: Inspect and clean the spark plugs. The gap between electrodes should be set at exactly 3/16".

2. BELTS AND PULLEYS: Check the alignment and condition of the pulleys. Check the condition and tension of belts. Adjust the tension of belts if necessary. Belts should always be replaced in complete sets. The numbers on the V-belts are sag numbers and should be used to match the belts in sets. A difference of one number up or one number down is permitted in matching a set of belts.

3. WATER PUMP: The pump used on the 4516 steam generator should have the grooves in the piston rods cleaned.

4. FUEL PUMP: Inspect for leaks and loose mounting. Check the flexible coupling.

5. VALVE STEMS: Check leaks -- repack stuffing boxes where necessary.

6. STEAM TEMPERATURE LIMIT CONTROL: Check the adjustment and make sure the operating rod moves freely.

## 12,000 MILE -- FREIGHT SERVICE
## 24,000 MILE -- PASSENGER SERVICE

1. WASH OUT: Descale the steam generator coils, if the feed water pressure goes up to 425 lbs. during operation of the steam generator. Make record of date.

2. SOOT: Remove inspection plates and blow soot from coils with 100 lbs. air pressure; use wire brush where necessary. Clean all soot from the base of the coils. Make a hammer test on the outer coils to detect weakened spots.

## 12,000 MILE -- FREIGHT SERVICE
## 24,000 MILE -- PASSENGER SERVICE
(continued)

3. **RELAYS:** Inspect all contacts on relays and on all switches on the electrical devices. Clean or replace as required.

4. **WATER TANK:** Drain and flush out the water supply tanks.

5. **MOTOR:** Check commutator and brushes, take off plate and clean collector rings (slip ring).

6. **WATER TREATMENT TANK OR STRAINER TANK:** Drain sediment out of tank.

7. **TREATMENT INJECTOR** (where used): Clean the sediment out of the treatment filter in the line between the solution tank and injector pump.

8. **MAGNETIC TRAINLINE SHUT-OFF VALVE:** Repack the valve stem.

9. **SERVO-FUEL CONTROL:** Clean the diaphragm chamber and the water metering valve stem and seat. Renew the diaphragm if it shows wear or loss of flexibility and strength.

10. **FUEL FILTERS:** Drain the suction line filter. Clean the filter element in the pressure line.

11. **STEAM TRAPS:** Clean and check operation.

## 36,000 MILE -- FREIGHT SERVICE
## 72,000 MILE -- PASSENGER SERVICE

1. **STACK SWITCH:** Inspect and check its setting. Test the helix in a test furnace -- high temperature contacts should open at 900° F. Low temperature contacts should close at 250° F. on DRK units, at 300° F. on OK units.

## 36,000 MILE -- FREIGHT SERVICE
## 72,000 MILE -- PASSENGER SERVICE
(continued)

2. **OIL FILTER:** Clean the filter element on the suction line filter.

3. **STEAM TEMPERATURE LIMIT CONTROL:** Renew the control shaft packing and reset the control.

4. **TREATMENT INJECTOR PUMP** (where used): Replace the diaphragm and check the valve for scoring and/or improper seating.

5. **WATER PUMP:** Check the water pump packing.

## 72,000 MILE -- FREIGHT SERVICE
## 144,000 MILE -- PASSENGER SERVICE

1. **DIAPHRAGMS:** Replace diaphragms in the DRK fuel spray head, servo-fuel control and water by-pass regulator.

2. **MOTOR:** Blow out dirt with dry compressed air at not over 40 lbs pressure. Direct the air flow so that the dirt is blown out of the end shields and away from the armature. Examine brushes, brush-holders, commutator, commutator clamping ring and collector rings; clean holders and check brush pressure and position; wipe commutator and brushes and clean with a cloth dampened in carbon tetrachloride. Replace brushes that are more than half worn. Be sure anchor bolts are secure and that covers are securely fastened.

3. **CHECK VALVES:** Inspect and clean. Replace or lap valve and seat if worn.

4. **WATER RELIEF VALVE:** Take apart and clean.

## 120,000 MILE -- FREIGHT SERVICE
## 240,000 MILE -- PASSENGER SERVICE

1. **WATER SUPPLY TANK**: When washing out the steam generator, also wash out the water supply tank and the water suction line between the main storage tank and the treater.

2. **STACK SWITCH**: Check in testing furnace and replace if inaccurate.

3. **WATER PUMP**: Overhaul the water pump or send it to the Vapor Heating Corporation for factory overhauling.

4. **WATER BY-PASS REGULATOR**: Overhaul.

5. **SERVO-FUEL CONTROL**: Inspect and overhaul -- or change out and send to the Vapor Heating Corporation.

6. **REMOTE CONTROL EQUIPMENT**: Inspect and overhaul electric equipment and magnet trainline valve.

7. **SOLENOID AND RELAY COILS**: Test the insulation resistance of all coils and the ignition transformer (Megger Test).

8. **HYDROSTATIC TEST**: Test the steam generator by subjecting it to hydrostatic pressure 25% above the working steam pressure.

9. **SEPARATOR BLOWDOWN VALVE**: Inspect the air cylinder and lubricate. Take up the wear in the operating lever.

10. **BLOWER FAN**: Check fan bearings for wear, remove and clean the fan and clean the air inlet duct in the roof.

11. **MOTOR CONVERTER**: Overhaul the motor and converter. Check the sealed bearings. If it is necessary to grease the bearings, use Norma Hoffman high temperature grease G-75 or Dow Corning D.C. 44 or equivalent. Do not use a high pressure grease gun -- it will force out the grease seal and injure the bearing surfaces. Release the snap ring which holds the grease seal in place, remove the bearing and wash it thoroughly in solvent. Then repack the bearing, replace the grease seal and reinstall the bearing.

## 120,000 MILE -- FREIGHT SERVICE
## 240,000 MILE -- PASSENGER SERVICE
(continued)

It is recommended that the grease fittings on the bearing housing be removed and pipe plugs inserted.

12. **FIRE POT**: Inspect and repair if necessary.

13. **COIL BLOWDOWN VALVE**: Inspect for leaks and tight seating of the swing gate valve.

14. **COIL RETAINER AND PADS**: Check and replace if the coil pads are torn or burned or if the coil retainer is flaky and burned. See that the coil refractory and refractory container are not cracked or chipped.

## LUBRICATION

Refer to Lubrication Schedule.

## LUBRICATION SCHEDULE
## 1500 HP ROAD SWITCHER LOCOMOTIVE

### DAILY OR TRIP

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 1 | Diesel Engine | Engine Lube Oil | Check level. Change oil as examination indicates - capacity 200 gal. |
| 2 | Air Compressor | Engine Lube Oil | Check level. Change oil as examination indicates - capacity 12 qts. |
| 3 | Engine Governor | Governor Oil | Tank with bayonet gauge - maintain 2/3 full - capacity 2-1/2 gallons. |
| | | | Tank with sight glass - maintain level in glass 1/2 full - capacity 1-1/2 gallons. |
| 4 | Journal Box Friction Bearing | Car Oil | Saturate Waste |

### 3000 MILES

| | | | |
|---|---|---|---|
| 5 | Traction Motor Axle Bearing | Electric Car Oil | Oil filler pipe - fill axle caps using pressure gauge. |
| 6 | Traction Motor Gear Case | No. 2 Crater compound or equivalent | Add 2 lbs. - maintain heavy film of grease on gear teeth - initial filling approximately 10 lbs. |
| 7 | Steam Generator Vapor-Clarkson Type DRK-4516 OK -4616 | No. 2 cup grease | Blower Fan Bearing - lubricate. |
| | | | Belt tension adjuster bearing - lubricate. |
| | | Engine Lube Oil | Damper control rod linkage - lubricate. |
| | | | Damper bearings - lubricate. |
| | | | Water pump - maintain oil level at high mark on bayonet gauge |
| 8 | Radiator Shutter Filter-Lubricator | SAE-10 Automotive Oil | Fill |

### 6000 MILES

| | | | |
|---|---|---|---|
| 9 | Traction Motor Armature Bearing (Non-sealed type) | G.E. Ball Bearing grease D6A2A3 | Pinion end - add 4 oz. - initial filling 28 oz. |

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| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|

### 12,000 MILES

| | | | |
|---|---|---|---|
| 10 | Radiator Fan Gear Box | Engine Lube Oil | Fill to top of filler pipe with engine shut down. |
| 11 | Reverser | Stazrite No. 30 or equivalent | Gear segments. Apply thin film of grease on teeth. |
| | | | Cam - apply thin film of grease. |
| 12 | Controller | Stazrite No. 30 or equivalent | Gear segments - apply thin film of grease on teeth. |
| 13 | Electro Pneumatic Contactors | GE PC No 1 Oil | Add 3 to 4 drops to oil hole in cylinder. |
| 14 | Fan Drive Shaft | Gear Lubricant SAE 140 | Add lubricant to upper and lower fan bearing, universal joint, sleeve yoke and spline shaft. |
| 15 | Flexible Coupling (Falk) | Marfak No. 3 HD or equivalent | Add lubricant. |
| 16 | Flexible Coupling (Fast) | Crater compound No. 1 or equiv. | Add lubricant. |
| 17 | Door and Window Hardware | Light Machine Oil | Lubricate with hand oiler. |
| 18 | Air Brakes | | Follow manufacturer's instructions. |
| 19 | Brake Rigging | Car Oil | Lubricate Pins and Bushings. |
| 20 | Governor Linkage | Light Machine Oil | Lubricate Pins and Bushings. |
| 21 | Center Plate | Car Oil | Fill cup. |
| 22 | Radiator Shutters and Linkage | Car Oil | Lubricate with hand oiler. |
| 23 | Pedestal Liners | Alemite Oil | Lubricate with pressure gun. |
| 24 | Side Bearings | Alemite Grease | Apply thin film to bearing surface. |
| 25 | Steam Generator Vapor Clarkson Type DRK-4516 OK -4616 | Engine Lube Oil | Water Pump - change oil. |
| | | High Temperature Grease | Stack switch bearing - Apply light coating. |
| | | Dashpot Oil | Dashpot relay - fill dashpot if necessary. |
| 26 | Battery | Petroleum Jelly | Coat Terminals |

### 36,000 MILES

| | | | |
|---|---|---|---|
| 27 | Traction Motor Armature Bearing (Non-sealed type) | G.E. Ball Bearing grease D6A2A3 | Commutator end - add 2 oz. Initial 10 oz. |

### 36,000 MILES (cont'd)

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 28 | Traction Motor Blower Shaft Bearings | G.E. Ball Bearing grease D6A2A3 | Add 1/8 oz. each bearing. |
| 29 | Motor Alternator Armature Bearing | G.E. Ball Bearing grease D6A2A3 | Fill till grease is expelled from overflow with set not running. |
| 30 | Fuel Pump Motor Armature Bearings | G. E. Ball Bearing grease D6A2A3 | Type 5BC 76 AB 286 - Fill till grease is expelled from overflow with set not running. |
| | | | Type 5BC 66AB 1882 - do not lubricate. Sealed bearings. |
| 31 | Eddy Current Clutch Shaft Bearing | G. E. Ball Bearing grease D6A2A3 | Add 1/2 oz. |
| 32 | Radiator Fan Gear Box | Engine Lube Oil | Drain and refill. |
| 33 | Governor Tachometer Generator Armature Bearings | G.E. Ball Bearing Grease D6A2A3 | Fill till grease is expelled from relief fitting with engine shut down. |
| 34 | Crankcase Exhauster Motor Armature Bearings | Engine Lube Oil | Add 4 to 6 drops. |
| 35 | Cab Heater Motor Armature Bearings | Engine Lube Oil | Add 3 to 4 drops. |
| 36 | Reverser | Light Machine Oil | Oilite Bearings - add 4 to 6 drops to each bearing. |
| | | | Cam Rollers - add 4 to 6 drops. |
| 37 | Controller | Light Machine Oil | Oilite Bearings - add 3 to 4 drops to each bearing. |
| | | | Cam Rollers - Add 3 to 4 drops. |
| 38 | Diesel Engine Turning Device | Alemite Grease | Apply to grease fittings. Apply thin film to worm and worm gear teeth. |
| 39 | Hand Brake | Car Oil | Lubricate with hand oiler. |

### 72,000 MILES

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 40 | Amplidyne Exciter Armature Bearing | G.E. Ball Bearing Grease D6A2A3 | Commutator end - add 1/4 oz. Initial filling 2 oz.<br>Pinion end - add 1/4 oz. Initial filling 3 oz. |
| 41 | Auxiliary generator Armature bearing | G.E. Ball Bearing grease D6A2A3 | Commutator end - add 1/4 oz. Initial filling 2 oz.<br>Pinion end - add 1/4 oz. Initial filling 3 oz. |

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### 72,000 MILES (cont'd)

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 42 | Axle Generator Armature Bearing | G.E. Ball Bearing grease D6A2A3 | Type CM 4 used with manual transition. Repack with 1/4 oz. |
| 43 | Reverser | G.E. PC No. 2 grease | Air cylinders - apply thin film on walls. |
| | | G.E. PC No. 1 oil | Air cylinder piston leathers. Soften in oil. |
| 44 | Electro Pneumatic Contactors | G.E. PC No. 2 grease | Air Cylinders - Apply thin film on walls. |
| | | G.E. PC No. 1 oil | Air Cylinder Piston Leathers. Soften in oil. |

### 120,000 MILES

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 45 | Traction Generator Bearing | Medium Heavy Machine Oil | Add 1/4 pint (belt driven auxiliaries). |
| 46 | Traction Motor Axle Bearing Waste Pocket | Electric Car Oil | Repack with long fibre all wool waste treated with oil. Repack at wheel change. |
| 47 | Motor Alternator Armature Bearings | G.E. Ball Bearing grease D6A2A3 | Repack |
| 48 | Axle Generator Armature Bearings | G.E. Ball Bearing grease D6A2A3 | Type GYA3 used with automatic transition. Repack with 1-3/4 oz. |
| 49 | Governor Tachometer Generator Armature Bearing | G.E. Ball Bearing grease D6A2A3 | Repack |
| 50 | G. E. Fan Control | G.E. Ball Bearing grease D6A2A3 | Motor Bearings - repack. |
| | | G.E. PC No. 2 grease | Gear Box - repack with 1/3 lb. |
| 51 | Crankcase Exhauster Motor Armature Bearings | G.E. Ball Bearing grease D6A2A3 | Repack 1/3 full. |
| 52 | Cab Heater Motor Armature Bearings | G.E. Ball Bearing grease D6A2A3 | Replace or repack 1/2 full. |
| 53 | Fan Drive Shaft | Gear Lubricant SAE 140 | Repack upper and lower fan bearings, universal joint, sleeve yoke and spline shaft. |
| 54 | Flexible Coupling (Falk) | Marfak No. 3 HD or equivalent | Repack |
| 55 | Flexible Coupling (Fast) | Crater compound No. 1 or equivalent | Repack |
| 56 | Windshield Wiper | GE PC No. 2 grease | Lubricate all working parts. |
| 57 | Bell Ringer | Light Machine Oil | Lubricate all working parts |

120,000 MILES (cont'd)

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 58 | Steam Generator Vapor-Clarkson DRK-4516 OK -4616 | Dow Corning DC44 or equivalent | Motor Convertor Bearings. Lubricate. |

240,000 MILES

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 59 | Traction Generator Bearing | G.E. Ball Bearing Grease D6A2A3 | Repack with 44 oz. (Belt driven auxiliaries). |
| 60 | Traction Motor Armature Bearings (Sealed Type) | G.E. Ball Bearing Grease D6A2C4 | Commutator end - repack with 10 oz.<br>Pinion end - repack with 28 oz. |

## LUBRICATION SCHEDULE
## 1500 HP ROAD FREIGHT LOCOMOTIVE

DAILY OR TRIP

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 1 | Diesel Engine | Engine Lube Oil | Check level. Change oil as examination indicates. Capacity 200 gal. |
| 2 | Air Compressor | Engine Lube Oil | Check level. Change oil as examination indicates. Capacity 12 qts. |
| 3 | Engine Governor | Governor Oil | Tank with bayonet gauge - maintain 2/3 full - capacity 2-1/2 gallons.<br>Tank with sight glass - maintain level in sight glass 1/2 full. Capacity 1-1/2 gallons |

3000 MILES

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 4 | Traction Generator Bearing | Engine Lube Oil | Maintain level at high mark on bayonet gauge with threads disengaged and engine shut down. Capacity 5 pints. (Gear driven auxiliaries). |
| 5 | Traction Motor Axle Bearing | Electric Car Oil | Oil filler pipe. Fill axle caps using pressure gauge. |
| 6 | Traction Motor Gear Case | No. 2 Crater compound or equivalent | Add 2 lbs. - maintain heavy film of grease on gear teeth. Initial filling approximately 10 lbs. |
| 7 | Journal Box Timken Roller Bearing | Journal Oil | Maintain level to pipe plug hole. |
| 8 | Radiator shutter Filter-lubricator | SAE-10 Automotive Oil | Fill |

6000 MILES

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 9 | Traction Motor Armature Bearing (Non-sealed type) | G.E. Ball Bearing grease D6A2A3 | Pinion end - add 4 oz. Initial filling 28 oz. |

12,000 MILES

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 10 | Radiator Fan Gear Box | Engine Lube Oil | Fill to top of filler pipe with engine shut down. |
| 11 | Reverser | Stazrite No. 30 or Equivalent | Gear segments. Apply thin film of grease on teeth. |
| 12 | Braking Switch | | Cam - apply thin film of grease. |
| 13 | Controller | Stazrite No. 30 or equivalent | Gear segments. Apply thin film of grease on teeth. |

### 12,000 MILES (cont'd)

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 14 | Electric Pneumatic Contactors | G.E. PC No. 1 Oil | Add 3 to 4 drops to oil hole in cylinder. |
| 15 | Fan Drive Shaft | Gear Lubricant SAE 140 | Add lubricant to upper and lower fan bearings, universal joint, sleeve yoke and spline shaft. |
| 16 | Flexible Coupling (Falk) | Marfak No. 3 HD or equivalent | Add lubricant. |
| 17 | Flexible Coupling (Fast) | Crater compound No. 1 or equivalent | Add lubricant. |
| 18 | Door and Window Hardware | Light Machine Oil | Lubricate with hand oiler. |
| 19 | Vestibule Diaphragm Plate | Car Oil | Lubricate with hand oiler. |
| 20 | Air Brakes | | Follow manufacturer's instructions. |
| 21 | Brake Rigging | Car Oil | Lubricate pins and bushings. |
| 22 | Governor Linkage | Light Machine Oil | Lubricate pins and bushings. |
| 23 | Center Plate | Car Oil | Fill cup. |
| 24 | Radiator shutters and linkage | Car Oil | Lubricate with hand oiler. |
| 25 | Pedestal Liners | Alemite Oil | Lubricate with pressure gun. |
| 26 | Side Bearings | Alemite Grease | Apply thin film to bearing surface. |
| 27 | Battery | Petroleum Jelly | Coat terminals. |

### 36,000 MILES

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 28 | Traction Motor Armature Bearing (Non-sealed type) | G.E. Ball Bearing Grease D6A2A3 | Commutator end - add 2 oz. Initial filling 10 oz. |
| 29 | Traction Motor Blower Motor Armature Bearing | G.E. Ball Bearing Grease D6A2A3 | Fan end - add 1/2 oz. Initial filling 1/2 oz. Commutator end - add 1/8 oz. Initial filling 1 oz. |
| 30 | Motor Alternator Armature Bearing | G.E. Ball Bearing Grease D6A2A3 | Fill till grease is expelled from overflow with set not running. |
| 31 | Fuel Pump Motor Armature Bearings | G.E. Ball Bearing Grease D6A2A3 | Type 5BC76AB286 - fill till grease is expelled from overflow with set not running.<br>Type 5BC66AB1882 - do not lubricate - sealed bearings. |
| 32 | Eddy Current Clutch Shaft Bearings | G.E. Ball Bearing Grease D6A2A3 | Add 1/2 oz. |
| 33 | Radiator Fan Gear Box | Engine Lube Oil | Drain and refill. |
| 34 | Governor Tach. Gen. Armature Bearing | G.E. Ball Bearing Grease D6A2A3 | Fill till grease is expelled from relief fitting with engine shut down. |

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### 36,000 MILES (cont'd)

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 35 | Crankcase Exhauster Motor Armature Bearings | Engine Lube Oil | Add 4 to 6 drops. |
| 36 | Cab Heater Motor Armature Bearings | Engine Lube Oil | Add 3 to 4 drops. |
| 37 | Defroster Motor Armature Bearings | Engine Lube Oil | Add 3 to 4 drops. |
| 38 | Reverser | Light Machine Oil | Oilite bearings - add 4 to 6 drops to each bearing. |
| 39 | Braking Switch | | Cam rollers - add 4 to 6 drops. |
| 40 | Controller | Light Machine Oil | Oilite bearings - add 3 to 4 drops to each bearing.<br>Cam rollers - add 3 to 4 drops. |
| 41 | Diesel Engine Turning Device | Alemite Grease | Apply to grease fittings. Apply thin film to worm and worm gear teeth. |
| 42 | Windshield Wipers | Light Machine Oil | Saturate oil retainer felts. |
| 43 | Hand Brake | Car Oil | Lubricate with hand oiler. |

### 72,000 MILES

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 44 | Amplidyne Exciter Armature Bearing | G.E. Ball Bearing Grease D6A2A3 | Commutator end - add 1/4 oz. Initial filling 2 oz. |
| 45 | Auxiliary Generator Armature Bearing | G.E. Ball Bearing Grease D6A2A3 | Commutator end - add 1/4 oz. Initial filling 2 oz. |
| 46 | Blower Generator Armature Bearing | G.E. Ball Bearing Grease D6A2A3 | Commutator end - add 1/4 oz. Initial filling 2 oz. |
| 47 | Axle Generator Armature Bearings | G.E. Ball Bearing Grease D6A2A3 | Type CM4 used with manual transition. Repack with 1/8 oz. |
| 48 | Reverser | G.E. PC No. 2 Grease | Air Cylinders - Apply thin film on walls. |
| | | G.E. PC No. 1 Oil | Air Cylinder Piston Leathers. Soften in oil. |
| 49 | Braking Switch | G.E. PC No. 2 Grease | Air Cylinders - Apply thin film on walls. |
| | | G.E. PC No. 1 Oil | Air Cylinder Piston Leathers. Soften in oil. |
| 50 | Electro Pneumatic Contactors | G.E. PC No. 2 Grease | Air Cylinders - Apply thin film on walls. |
| | | G.E. PC No. 1 Oil | Air Cylinder Piston Leathers. Soften in oil. |

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| | | **120,000 MILES** | |
| 51 | Traction Motor Axle Bearing Waste Pocket | Electric Car Oil | Repack with long fibre all wool waste treated with oil(or at wheel change). |
| 52 | Traction Generator Bearing | Medium Heavy Machine Oil | Add 1/4 pint (belt driven auxiliaries). |
| 53 | Motor Alternator Armature Bearings | G.E. Ball Bearing Grease D6A2A3 | Repack. |
| 54 | Axle Generator Armature Bearings | G.E. Ball Bearing Grease D6A2A3 | Type GYA3 used with automatic transition. Repack with 1-3/4 oz. |
| 55 | Governor Tach. Gen. Armature Bearings | G.E. Ball Bearing Grease D6A2A3 | Repack |
| 56 | G.E. Fan Control | G.E. Ball Bearing Grease D6A2A3 | Motor bearings - repack. |
| | | G.E. PC No. 2 Grease | Gear box - Repack with 1/3 lb. |
| 57 | Crankcase Exhauster Motor Armature Bearings | G.E. Ball Bearing Grease D6A2A3 | Repack 1/3 full. |
| 58 | Cab Heater Motor Armature Bearings | G.E. Ball Bearing Grease D6A2A3 | Replace or repack 1/3 full. |
| 59 | Defroster Motor Armature Bearings | G.E. Ball Bearing Grease D6A2A3 | Replace or repack 1/3 full |
| 60 | Braking Resistor Blower Motor Armature Bearing | G.E. Ball Bearing Grease D6A2A3 | Add 1/8 oz. to each bearing. |
| 61 | Fan Drive Shaft | Gear Lubricant SAE 140 | Repack upper and lower fan bearings, universal joint, sleeve yoke and spline shaft. |
| 62 | Flexible Coupling (Falk) | Marfak No. 3 HD or equivalent | Repack |
| 63 | Flexible Coupling (Fast) | Crater compound No. 1 or equivalent | Repack |
| 64 | Windshield Wipers | G.E. PC No. 2 Grease | Lubricate all working parts, diaphragm leathers and cylinder walls. |
| 65 | Bell Ringer | Light Machine Oil | Lubricate working parts. |
| | | **240,000 MILES** | |
| 66 | Traction Motor Armature Bearings (Sealed Type) | G.E. Ball Bearing Grease D6A2C4 | Commutator end - repack with 10 oz. |
| | | | Pinion end - repack with 28 oz. |
| 67 | Traction Generator Bearing | G.E. Ball Bearing Grease D6A2A3 | Repack with 44 oz. (Belt driven auxiliaries). |

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## LUBRICATION SCHEDULE
## 2000 HP ROAD PASSENGER LOCOMOTIVE

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| | | **DAILY OR TRIP** | |
| 1 | Diesel Engine | Engine Lube Oil | Check level. Change oil as examination indicates. Capacity 230 gal. |
| 2 | Air Compressor | Engine Lube Oil | Check level. Change oil as examination indicates. Capacity 12 qts. |
| 3 | Engine Governor | Governor Oil | Tank with bayonet gauge - maintain 2/3 full - capacity 2-1/2 gallons. |
| | | | Tank with sight glass - maintain level in sight glass 1/2 full. Capacity 1-1/2 gallons. |
| 3A | Steam Generator Vapor-Clarkson DRK-4530 OK -4630 | No. 2 Cup Grease | Blower fan bearings - lubricate. |
| | | Engine Lube Oil | Damper bearings - lubricate. |
| | | **6000 MILES** | |
| 4 | Traction Generator Bearing | Engine Lube Oil | Maintain level at high mark on bayonet gauge with threads disengaged and engine shut down. Capacity 5 pints. (Gear driven auxiliaries). |
| 5 | Traction Motor Armature Bearing (Non-sealed type) | G.E. Ball Bearing Grease D6A2A3 | Pinion end - add 4 oz. Initial filling 28 oz. |
| 6 | Traction Motor Axle Bearing | Electric Car Oil | Oil filler pipe - fill axle caps using pressure gauge. |
| 7 | Traction Motor Gear Case | No. 2 Crater compound or equivalent | Add 2 lbs. - maintain heavy film of grease on gear teeth. Initial filling approximately 10 lbs. |
| 8 | Journal Box Timken Roller Bearing | Journal Oil | Maintain level to pipe plug hole. |
| 9 | Steam Generator Vapor-Clarkson DRK-4530 OK -4630 | No. 2 Cup Grease | Belt tension adjuster bearing - lubricate. |
| | | Engine Lube Oil | Damper control rod linkage - lubricate. |
| | | | Damper bearings. Lubricate. |
| | | Automotive Oil<br>SAE 20 (winter)<br>SAE 30 (summer) | Water Pump. Check oil level at petcock. Capacity 3 quarts. |
| 10 | Radiator shutter Filter-lubricator | SAE-10 Automotive Oil | Fill |

## 24,000 MILES

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 11 | Radiator Fan Gear Box | Engine Lube Oil | Fill to top of filler pipe with engine shut down. |
| 12 | Reverser | Stazrite No. 30 or equivalent | Gear segments - apply thin film of grease on teeth. |
| | | | Cam - apply thin film of grease. |
| 13 | Braking Switch | Stazrite No. 30 or equivalent | Gear segments - apply thin film of grease on teeth. |
| | | | Cam - apply thin film of grease. |
| 14 | Controller | Stazrite No. 30 or equivalent | Gear segments - apply thin film of grease on teeth. |
| 15 | Electro-pneumatic Contactors | G.E. PC No. 1 Oil | Add 3 to 4 drops to oil hole in cylinder. |
| 16 | Field shunting controller | SAE-10 Automotive Oil | Main finger rollers "A" form - add 1 to 2 drops. |
| | | | Armature roller - add 2 to 3 drops. |
| 17 | Fan Drive Shaft | Gear Lubricant SAE-140 | Add lubricant to upper and lower fan bearings, universal joint, sleeve yoke and spline shaft. |
| 18 | Flexible Coupling (Falk) | Marfak No. 3 HD or equivalent | Add lubricant. |
| 19 | Flexible Coupling (Fast) | Crater compound No. 1 or equivalent | Add lubricant. |
| 20 | Door and window hardware | Light Machine Oil | Lubricate with hand oiler. |
| 21 | Vestibule Diaphragm Plate | Car Oil | Lubricate with hand oiler. |
| 22 | Air Brakes | | Follow manufacturer's instructions. |
| 23 | Brake Rigging | Car Oil | Lubricate pins and bushings. |
| 24 | Governor Linkage | Light Machine Oil | Lubricate pins and bushings. |
| 25 | Center Plate | Car Oil | Fill cup. |
| 26 | Radiator Shutters and Linkage | Car Oil | Lubricate with hand oiler. |
| 27 | Swing Hanger Bearings | Alemite grease | Lubricate with pressure gun. |
| 28 | Pedestal Liners | Alemite Oil | Lubricate with pressure gun. |
| 29 | Side Bearings | Alemite Grease | Apply thin film to bearing surface. |

## 24,000 MILES (cont'd)

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 30 | Steam Generator Vapor-Clarkson DRK-4530 OK -4630 | Automotive Oil SAE 20 (winter) SAE 30 (summer) | Water pump. Change Oil. |
| | | High temperature grease | Stack switch bearing. Apply light coating. |
| | | Dashpot Oil | Dashpot relay. Fill dashpot if necessary. |
| 31 | Battery | Petroleum Jelly | Coat terminals. |

## 36,000 MILES

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 32 | Traction Motor Armature Bearing (Non-sealed Type) | G.E. Ball Bearing Grease D6A2A3 | Commutator end. Add 2 oz. Initial filling 10 oz. |

## 72,000 MILES

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 33 | Traction Motor Blower Motor Armature Bearing | G.E. Ball Bearing Grease D6A2A3 | Fan end - add 1/2 oz. Initial filling 1/2 oz. |
| | | | Commutator end - add 1/8 oz. Initial filling 1 oz. |
| 34 | Motor Alternator Armature Bearings | G.E. Ball Bearing Grease D6A2A3 | Fill till grease is expelled from overflow with set not running. |
| 35 | Fuel Pump Motor Armature Bearings | G.E. Ball Bearing Grease D6A2A3 | Type 5BC76AB286. Fill till grease is expelled from overflow with set not running. |
| | | | Type 5BC66AB1882 - do not lubricate. Sealed bearings. |
| 36 | Eddy Current Clutch Shaft Bearings | G.E. Ball Bearing Grease D6A2A3 | Add 1/2 oz. |
| 37 | Radiator Fan Gear Box | Engine Lube Oil | Drain and Refill. |
| 38 | Governor Tach. Gen. Armature Bearing | G.E. Ball Bearing Grease D6A2A3 | Fill till grease is expelled from relief fitting with engine shut down. |
| 39 | Crankcase Exhauster Motor Armature Bearings | Engine Lube Oil | Add 4 to 6 drops. |
| 40 | Cab Heater Motor Armature Bearings | Engine Lube Oil | Add 3 to 4 drops. |
| 41 | Defroster Motor Armature Bearings | Engine Lube Oil | Add 3 to 4 drops. |

**72,000 MILES** (cont'd)

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 42 | Reverser | Light Machine Oil | Oilite Bearings - add 4 to 6 drops to each bearing. |
| | | | Cam rollers - add 4 to 6 drops. |
| 43 | Braking Switch | Light Machine Oil | Oilite Bearings - add 4 to 6 drops to each bearing. |
| | | | Cam rollers - add 4 to 6 drops. |
| 44 | Controller | Light Machine Oil | Oilite Bearings - add 3 to 4 drops to each bearing. |
| | | | Cam rollers - add 3 to 4 drops. |
| 45 | Field Shunting Controller | Light Machine Oil | Main finger rollers "B" and "C" forms - maintain thin film of oil. |
| | | | Interlock rollers - maintain thin film of oil. |
| 46 | Diesel Engine Turning Device | Alemite Grease | Apply to grease fittings. Apply thin film to worm and worm gear teeth. |
| 47 | Windshield Wiper | Light Machine Oil | Saturate oil retainer felts. |
| 48 | Handbrake | Car Oil | Lubricate with hand oiler. |

**100,000 MILES**

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 49 | Traction Motor Axle Bearing Waste Pocket | Electric Car Oil | Repack with long fibre all wool waste treated with oil. Repack at wheel change. |
| 50 | Amplidyne Exciter Armature Bearing | G.E. Ball Bearing Grease D6A2A3 | Commutator end - add 1/4 oz. Initial filling 2 oz. |
| 51 | Auxiliary Gen. Armature Bearing | G.E. Ball Bearing Grease D6A2A3 | Commutator end - add 1/4 oz. Initial filling 2 oz. |
| 52 | Blower Generator Armature Bearing | G.E. Ball Bearing Grease D6A2A3 | Commutator end - add 1/4 oz. Initial filling 2 oz. |

**144,000 MILES**

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 53 | Reverser | G.E. PC No. 2 Grease | Air cylinders - apply thin film on walls. |
| | | G.E. PC No. 1 Oil | Air cylinder piston leathers. Soften in oil. |
| 54 | Braking Switch | G.E. PC No. 2 Grease | Air cylinders - apply thin film on walls. |
| | | G.E. PC No. 1 Oil | Air cylinder piston leathers. Soften in oil. |
| 55 | Electro-pneumatic Contactors | G.E. PC No. 2 Grease | Air cylinders - apply thin film on walls. |
| | | G.E. PC No. 1 Oil | Air cylinder piston leathers. Soften in oil. |

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**240,000 MILES**

| ITEM | EQUIPMENT | LUBRICANT | METHOD |
|---|---|---|---|
| 56 | Traction Motor Armature Bearings (Sealed Type) | G.E. Ball Bearing Grease D6A2C4 | Commutator end - repack with 10 oz. |
| | | | Pinion end - repack with 28 oz. |
| 57 | Motor Alternator Armature Bearing | G.E. Ball Bearing Grease D6A2A3 | Repack. |
| 58 | Axle Generator Armature Bearing | G.E. Ball Bearing Grease D6A2A3 | Type GYA3 - used with automatic transition. Repack with 1-3/4 oz. |
| 59 | Governor Tach. Gen. Armature Bearings | G.E. Ball Bearing Grease D6A2A3 | Repack. |
| 60 | G. E. Fan Control | G.E. Ball Bearing Grease D6A2A3 | Motor bearings - repack. |
| | | G.E. PC No. 2 Grease | Gear Box - repack with 1/3 lb. |
| 61 | Crankcase Exhauster Motor Armature Bearings | G.E. Ball Bearing Grease D6A2A3 | Repack 1/3 full. |
| 62 | Cab Heater Motor Armature Bearings | G.E. Ball Bearing Grease D6A2A3 | Replace or repack 1/3 full. |
| 63 | Defroster Motor Armature Bearings | G.E. Ball Bearing Grease D6A2A3 | Replace or repack 1/3 full. |
| 64 | Braking Resistor Blower Motor Armature Bearing | G.E. Ball Bearing Grease D6A2A3 | Add 1/8 oz. to each bearing. |
| 65 | Field Shunting Controller | G.E. Ball Bearing Grease D6A2A3 | Motor - ball bearing - repack 1/3 full. |
| | | Electric Car Oil | Motor - pinion end bushing - saturate wicks in motor pilot. |
| | | G.F. PC No. 2 Grease | Gear Case - repack with 1/2 lb. |
| 66 | Fan Drive Shaft | Gear Lubricant SAE 140 | Repack upper and lower fan bearings, universal joint, sleeve yoke and spline shaft. |
| 67 | Flexible Coupling (Falk) | Marfak No. 3 HD or equivalent | Repack. |
| 68 | Flexible Coupling (Fast) | Crater No. 1 compound or equivalent | Repack. |
| 69 | Windshield Wipers | G.E. PC No. 2 Grease | Lubricate all working parts, diaphragm leathers and cylinder walls. |
| 70 | Bell Ringer | Light Machine Oil | Lubricate Working Parts. |
| 71 | Steam Generator Vapor-Clarkson DRK-4530 OK -4630 | Dow Corning DC 44 or equivalent | Motor convertor bearings. Lubricate. |

## LUBRICANTS

The following is a list of lubricants referred to on the preceding pages.

**Alemite Grease** Good Grade

**Alemite Oil** Good Grade

**Car Oil** Good Grade conforming to AAR classification

**Crater Compound**

| | No. 1 | No. 2 |
|---|---|---|
| Appearance | | |
| By transmitted light - - - - - - - - - | Opaque | Opaque |
| By reflected light - - - - - - - - - - | Black | Black |
| Gravity, °API - - - - - - - - - - - - - | 13.4 | 11.7 |
| Viscosity | | |
| Saybolt Furol, Sec. @ 210°F - - - | 105 | 208 |
| Corrosion, Copper Strip @ 212°F - - - | Neg. | Neg. |

**Cup Grease No. 2**

Good Grade Calcium Soap Grease
Consistency, ASTM
Worked @ 77°F - - - - - - - - - - - - - 250-300
Viscosity of Mineral Oil
(SSU) @ 100° F - - - - - - - - - - - - - 300-325

**Dash Pot Oil**

**Dow Corning D.C. 44**

Worked Consistency - - - - - - - - - - - - - 250-270

**Electric Car Oil** Good Grade (summer and winter)

**Engine Lube Oil** High quality additive type, heavy duty lubricating oil of SAE 40 viscosity characteristics having passed the Alco 500 hour engine approval test.

**G.E. Ball Bearing Grease D6A2A3**

Worked consistency - - - - - - - - - - - - - 270-290
Flow Point - °F min. - - - - - - - - - - - - - 290
Mineral Oil Vis. SSU @ 100° F - - - - - - - - 220-400
Free Alkali % max.- - - - - - - - - - - - - - .35
Free Acid - - - - - - - - - - - - - - - - - Nil.
Water % Max. - - - - - - - - - - - - - - - .20
Ash % Max.- - - - - - - - - - - - - - - - - 5.0
Base - - - - - - - - Sodium - Calcium with anti-oxidant

**G.E. Ball Bearing Grease D6A2C4**

**G.E. PC No. 1 Oil**

**G.E. PC No. 2 Grease**

**Governor Oil** SAE 10 W non-detergent automotive type

**High Temperature Grease**

**Journal Oil**

| | Timken Specifications | |
|---|---|---|
| | Winter | Summer |
| Flash - Min. °F - - - - - - - - - - - - - | 300 | 300 |
| Fire - Min. °F - - - - - - - - - - - - - | 350 | 350 |
| Pour °F - - - - - - - - - - - - - - - - - | 0 | +10 |
| Viscosity Min. SSU @ 100 °F - - - - | 200 | 425 |
| Min. SSU @ 200 °F - - - - | 45 | 55 |
| Carbon Residue % Max. - - - - - - - - | 1.0 | 1.25 |
| Insolubles % Max. - - - - - - - - - - | .10 | .10 |
| Neutralization No. - - - - - - - - - - | .20 | .20 |
| Tarry Matter % Max. - - - - - - - - - | .10 | .10 |

**Light Machine Oil**

**Marfak No. 3 H.D.**

Consistency, ASTM
Unworked @ 77° F - - - - - - - - - - - - - 230
Worked @ 77° F - - - - - - - - - - - - - 230
Dropping Point, Deg. F. - - - - - - - - - - - 425
Soap, Sodium, % - - - - - - - - - - - - - - 15.5
Water, % - - - - - - - - - - - - - - - - - - 0.10
Corrosion, Copper Strip @ 167° F - - - - - - - Neg.
Mineral Oil Viscosity, SSU @ 210° F - - - - - 92.9

**Medium Heavy Machine Oil**

Flash Point, Min. °F - - - - - - - - - - - - 370
Fire Point, Min. °F - - - - - - - - - - - - - 420
Viscosity SSU @ 100° F - - - - - - - - - - - 550-580
Viscosity SSU @ 210° F - - - - - - - - - - - 53- 56

**Petroleum Jelly**

**SAE 10 Automotive Oil**

**SAE 20 Automotive Oil**

**SAE 30 Automotive Oil**

**SAE 140 Gear Lubricant**

**Stazrite No. 30**

Worked Consistency- - - - - - - - - - - - - 210-240
Flow Point °F - - - - - - - - - - - - - - - - 450
Mineral Oil Viscosity, SSU @ 100° F - - - - - - 400-2000
Free Alkali % Max. - - - - - - - - - - - - .60
Free Acid - - - - - - - - - - - - - - - - - Nil.
Water % Max. - - - - - - - - - - - - - - - .20
Ash % Max. - - - - - - - - - - - - - - - - 5.0
Base - - - - - - - - - Sodium-Calcium, Sodium or Lithium

| Subject | Pages 927 - 931 R.S. Item No. | Pages 932 - 935 Freight Item No. | Pages 936 - 940 Pass. Item No. |
|---|---|---|---|
| Air Brakes | 18 | 20 | 22 |
| Air Compressor | 2 | 2 | 2 |
| Amplidyne Exciter Armature Bearing | 40 | 44 | 50 |
| Auxiliary Generator Armature Bearing | 41 | 45 | 51 |
| Axle Generator Armature Bearing | 42, 48 | 47, 54 | 58 |
| Battery | 26 | 27 | 31 |
| Bell Ringer | 57 | 65 | 70 |
| Blower Generator Armature Bearing | | 46 | 52 |
| Brake Rigging | 19 | 21 | 23 |
| Braking Resistor Blower Motor Armature Bearings | | 60 | 64 |
| Braking Switch | | 12, 39, 49 | 13, 43, 54 |
| Cab Heater Motor Armature Bearings | 35, 52 | 36, 58 | 40, 62 |
| Center Plate | 21 | 23 | 25 |
| Contactors - Electro Pneumatic | 13, 44 | 14, 50 | 15, 55 |
| Controller | | | |
| Control Stand | 12, 37 | 13, 40 | 14, 44 |
| Field Shunting | | | 16, 45, 65 |
| Crankcase Exhauster Motor Armature Bearings | 34, 51 | 35, 57 | 39, 61 |
| Defroster Motor Armature Bearings | | 37, 59 | 41, 63 |
| Diesel Engine | 1 | 1 | 1 |
| Diesel Engine Turning Device | 38 | 41 | 46 |
| Door and Window Hardware | 17 | 18 | 20 |
| Eddy Current Clutch Shaft Bearings | 31 | 32 | 36 |
| Engine Governor | 3 | 3 | 3 |
| Fan Control - General Electric | 50 | 56 | 60 |
| Fan Drive Shaft | 14, 53 | 15, 61 | 17, 66 |
| Field Shunting Controller | | | 16, 45, 65 |
| Flexible Coupling | | | |
| Falk | 15, 54 | 16, 62 | 18, 67 |
| Fast | 16, 55 | 17, 63 | 19, 68 |
| Fuel Pump Motor Armature Bearings | 30 | 31 | 35 |
| Governor - Engine | 3 | 3 | 3 |
| Governor Linkage | 20 | 22 | 24 |
| Governor Tachometer Generator Armature Bearings | 33, 49 | 34, 55 | 38, 59 |
| Handbrake | 39 | 43 | 48 |
| Journal Box | 4 | 7 | 8 |
| Motor Alternator Armature Bearings | 29, 47 | 30, 53 | 34, 57 |
| Pedestal Liners | 23 | 25 | 28 |
| Radiator Fan Gear Box | 10, 32 | 10, 33 | 11, 37 |
| Radiator Shutter Filter Lubricator | 8 | 8 | 10 |
| Radiator Shutters and Linkage | 22 | 24 | 26 |
| Reverser | 11, 36, 43 | 11, 38, 48 | 12, 42, 53 |
| Shunter | | | 16, 45, 65 |
| Side Bearings | 24 | 26 | 29 |
| Steam Generator | | | |
| Belt Tension Adjuster Bearing | 7 | | 9 |
| Blower Fan Bearing | 7 | | 9, 3A |
| Damper Bearing | 7 | | 9, 3A |
| Damper Control Rod Linkage | 7 | | 9 |
| Dashpot Relay | 25 | | 30 |
| Motor Convertor | 58 | | 71 |
| Stack Switch Bearing | 25 | | 30 |
| Water Pump | 7, 25 | | 9, 30 |

| Subject | Pages 927 - 931 R.S. Item No. | Pages 932 - 935 Freight Item No. | Pages 936 - 940 Pass. Item No. |
|---|---|---|---|
| Swing Hanger Bearings | | | 27 |
| Traction Generator Bearing | 45, 59 | 4, 52, 67 | 4 |
| Traction Motor Armature Bearing | | | |
| Non-Sealed Type | 9, 27 | 9, 28 | 5, 32 |
| Sealed Type | 60 | 66 | 56 |
| Traction Motor Axle Bearing | 5 | 5 | 6 |
| Traction Motor Axle Bearing - Waste Pocket | 46 | 51 | 49 |
| Traction Motor Blower Motor Armature Bearing | | 29 | 33 |
| Traction Motor Blower Shaft Bearing | 28 | | |
| Traction Motor Gear Case | 6 | 6 | 7 |
| Vestibule Diaphragm Plate | | 19 | 21 |
| Window and Door Hardware | 17 | 18 | 20 |
| Windshield Wipers | 56 | 42, 64 | 47, 69 |

## NOTES

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# WIRING DIAGRAM SYMBOLS

Three fundamentals must be taken into consideration when reading an ALCO-GE locomotive wiring diagram.

1. Devices are shown in de-energized position.
2. Reverser contacts and interlocks are shown set up for FORWARD operation.
3. Circuits and devices are set up for MOTORING.

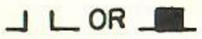
When any control handle is moved from one position or notch to another, it will close or open a contact and/or interlock which controls another circuit. A single handle may have several contacts controlling more than one circuit. If all contacts were shown at one location, and wires run to devices controlled by these contacts, the diagram would be very congested. To overcome this, just one contact in the circuit to be controlled is shown and the contact is marked.

Example:

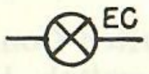
SH 2-3 - Contact will be closed only when the Selector Handle is in positions 2 or 3.

TH 1-8 - Contact will be closed only when the Throttle Handle is in notches 1 through 8.

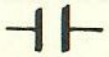
The same designation is used for the Engine Control Switch and Reverse Handle RH.



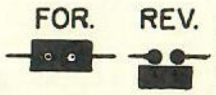
Controller Contacts (Open or closed). TH - Throttle Handle. SH - Selector Handle. RH - Reverse Handle. Letters or figures tell notches or position in which the contact is closed. Contacts shown in OFF position.



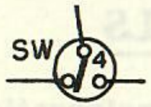
Engine Control Switch Contacts. Letters or figures after EC indicate positions in which contact is closed.



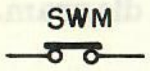
Reverser Main Contacts.



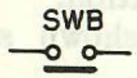
Reverser Interlock Contacts (Closed or open in Forward position respectively).



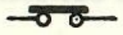
Braking Switch Main Contacts. (Shown in Motoring position. Throw oppositely in Braking. Figure in circle is contact number.)

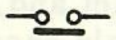


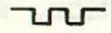
SWM Switch Interlocks. (Closed in Motoring).

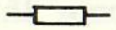


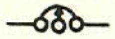
SWB Switch Interlocks. (Closed in Braking).

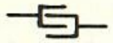

Interlock or Relay Contact. (On device marked. Closed with device de-energized).

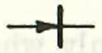

Interlock or Relay Contact. (On device marked. Closed with device energized).

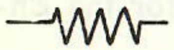

Resistor.

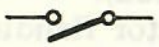

Tube Resistor.

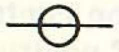

Rheostat or Potentiometer.

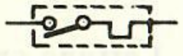

Capacitor.

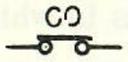

Rectifier. (Current flows in direction of arrow).

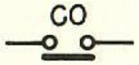

Field Coil. (Motor or Generator). Operating Coil of a device.


Contactor Main Tips or certain Relay Contacts.


Lamp Bulb.


Circuit Breaker.





Normally closed or open Cutout Switch Contacts. Throw oppositely when switch is operated; or if followed by numbers when those motors are cut out.

---

| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| A1 | Aux.Gen. | Supplies power for battery-charging and control circuits. | 4-pole, commutating pole, shunt-wound, d-c generator |
| A2 | Aux.Gen. | Supplies power for traction motor blowers. | Same as A1 |
| AR | Time Delay Relay | Co-operating with field shunting control relay, causes shunting one notch at a time. | Tip Gap - 1/32 in.<br>Wipe - 1/32 in.<br>Coil Res. - 762 ohms<br>Pick-up - 0.053<br>Drop-out - 20-40 percent |
| AVF | Sequence Relay | Commutates resistance in current limit control circuit. | Same as AR |
| AVS | Sequence Relay | Commutates resistance in governor speed circuit. | Same as AR |
| B | Battery Contactor | Connects battery to Auxiliary Generator | Tip Gap - 14-16/32 in.<br>Wipe - 12-14/32 in.<br>Lb Pressure - Initial 2.5-4<br>Final 3-4<br>Coil Resis. - 185 ohms<br>Amps. To Operate - 0.154<br>Continuous - 0.309 |

| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| B1, B2 | Braking Contactors | Connect traction-motor armatures to braking resistors. | Tip Gap - 14-18/32 in.<br>Lb Pressure<br>Initial 1.5-2.25<br>Final 30-40<br>Coil Resis. - 184 ohms<br>Amps. To Operate - 0.25 |
| BLR | Blower Stopped Relay | Energizes alarm signal, indicating lack of power. | Tip Gap - 1/32 in.<br>Wipe - 1/32 in.<br>Coil Resis. - 762 ohms<br>Pick-up - 0.023<br>Drop-out - 20-40 percent |
| BR1, BR2 | Braking Interlocks | Reconnect control circuits for dynamic braking. | Same as AR |
| BVS | Sequence Relay | Commutates resistance in current limit control and governor speed coil circuits. | Same as AR |
| BWR | Brake Overload Relay | Energizes warning light on dynamic braking overload. | Tip Gap - 1/32 in.<br>Wipe - 1/32 in.<br>Coil Resis. - 684 ohms<br>Pick-up - 0.090 ± 3 percent<br>Drop-out - 90 percent min. |

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| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| CO | Motor Cut-out Switch | Used to cut out traction motors if necessary. | |
| CR1 | Auto.Trans. Relay | Control relay - 1st to 2nd Auto. Transition. | Same as AR |
| CR2 | Auto.Trans. Relay | Control relay - 2nd to 3rd Auto. Transition. | Same as AR |
| CR3 | Auto.Trans. Relay | Control relay - 3rd to 4th Auto. Transition. | Same as AR |
| CS | Field Shunting Controller | Shunts traction motor fields for dynamic braking. | |
| CSC | Capacitor | Prevents arcing of IP1 contacts in CS | 1.0 mfd |
| CSD | Aux.Relay | Closes circuit, turning shunter "Off" or "Down". | Same as AR |

| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| CSR1 | Tube Resis. | Armature Resistance in CS. | 5/13.5 ohms full value. |
| CSR2 | Tube Resis. | Series field resistance in CS. | 15 ohms |
| CSR3 | Tube Resis. | In series with CSR1 - at "Off" or "Down". | 500 ohms |
| CSR4 | Tube Resis. | Discharge resistor in CS. | 1000 ohms |
| CSR5 | Tube Resis. | Discharge resistor in CS. | 1500 ohms |
| CSU | Aux.Relay | Closes circuit, turning shunter "Up" or "On". | Same as AR |
| CVF | Sequence Relay | Commutates resistance in current limit control circuits. | Same as AR |
| CVS | Sequence Relay | Commutates resistance in governor speed coil circuit. | Same as AR |
| DBM | Dyn.Brake Magnet Valve | Provides interlock between dynamic brake and independent air brake. | |
| DMR | Deadman's Relay | Opens control circuits - removing power. | Same as AR |
| DVS | Sequence Relay | Commutates resis.in gov.speed coil and current limit control circuits. | Same as AR |

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| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| E | Amplidyne Exciter | Supplies power for traction generator field excitation. | 4-pole, separately-excited, d-c generator. |
| EC | Eng.Control Switch | Engine start, stop, and limiting switch. | |
| EF | Exciter Fld. Relay | Energizes transf. to furnish excitation for amplidyne exciter. | Same as AR |
| ESR | Eng.Stop Relay | Stops engine by opening governor clutch coil circuit. | Same as AR |
| ETS | Eng.Temp. Switch | Idles engine, lights Hot engine light, rings alarm. | |
| FPC | Fuel Pump Contactor | Energizes motor-operated fuel pump. | Tip Gap - 18-21/32 in.<br>Wipe - 7-9/32 in.<br>Lb Pressure<br>Initial - 1.5-2<br>Final - 3-4<br>Coil Resis. - 185 ohms<br>Amps to Operate - .154<br>Continuous - .309 |

| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| G | Traction Generator | Furnishes power to traction motors. | 10 or 12-pole, commutating pole, shunt-wound, d-c generator. |
| GF | Gen.Field Contactor | Connects traction-generator field with amplidyne exciter armature. | Same as B. |
| GFR | Tube Resis. | Resistance across GF. | 28.5 ohms |
| GOP | Gov. Oil Press.Sw. | Shuts down engine if governor oil pressure fails. | Opens at 75 lb<br>Closes at 80 lb |
| GOV | Engine Governor | Regulates diesel-engine speed and fuel limit. | Speed Coil - 16 ohms<br>Stab. Coil - 55 ohms<br>Fuel Limit Coil - 16 ohms<br>Clutch Coil - 342 ohms |
| GR | Grd.Relay | Idles engine, removes power, lights warning light, and rings alarm when energized by a ground. | Tip gap - 1/32 in.<br>Wipe - 1/32 in.<br>Coil Resis. - 684 ohms<br>Pick-up - .063<br>Drop-out - 20-40 per cent |

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| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| GS | Cranking Contactor Light | Lights if cranking contactor remains closed after engine starts. | |
| GS1,2 | Cranking Contactors | Connect starting winding in traction generator to battery for cranking. | Tip Gap - 14-16/32 in.<br>Lb Pressure<br>Initial - 1.5-2.25<br>Final - 30-40<br>Coil Resis. - 27.5 ohms<br>Amps to Operate - .65<br>Continuous - 1.07 |
| IP1 | Interpoint Interlock | Primary CS interlock, closed between points but not in points. | |
| IP2 | Interpoint Interlock | Secondary CS interlock, closes after IP1. | |
| LOS | Locomotive Overspeed Switch | Returns engine to idle and applies air brakes at maximum permissible speed. | |

| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| LS1,2,3 | Speed Relays | Control CR1,2, and 3 respectively. | |
| M1-M2<br>M3-M4 | Field Shunting Contactors | Connect resistance across traction-motor fields. | Tip Gap - 13-16/32 in.<br>Wipe - 13-15/32 in.<br>Lb Pressure<br>Initial - 2.5-4<br>Final - 10-13<br>Coil Resis. - 237 ohms<br>Amps to Operate - .18<br>Continuous - .334 |
| MG | Motor Alternator | Furnishes power for T1. | 400-cycle, a-c generator |
| OPR | Oil Pressure Relay | Idles engine, lights warning, rings alarm on low lube-oil pressure or hot engine. | Same as AR. |
| OPS1 | Low Lube Oil Press. Sw. | Idles engine if lube-oil pressure drops to 20 lb in 5,6,7, or 8 notch. | Opens at 20 lb. |

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| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| OPS2 | Low Lube Oil Pressure Sw. | Shuts engine down if lube-oil pressure drops to 7 lb in any notch. | Opens at 7 lb. |
| OS | Engine Over-speed Switch | Shuts engine down on overspeed. | Set at 1100 ± 10 rpm. |
| OSM | Overspeed Mag.Valve | Cuts out dynamic braking and applies air brake on locomotive overspeed. | |
| P1 | Parallel Motor Contactor | Connects No. 3 motor across traction generator. | Tip Gap - 17-21/32 in.<br>Wipe - 28-36/32 in.<br>Lb Pressure<br>Initial - 9.5-13<br>Final - 25-35<br>Coil Resis. - 775 ohms |
| P2 | Parallel Motor Contactor | Connects No. 1 motor across traction generator. | Same as P1. |

| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| P21 | Parallel Motor Contactor | Connects No. 2 motor across traction generator. | Same as P1 |
| P22 | Parallel Motor Contactor | Connects No. 4 motor across traction generator. | Same as P1 |
| PCS | Deadman's Switch | Pneumatic switch, energizes DMR. | WAB-F1 |
| R1 | Exciter Fld. Rectifier | Supplies d-c for amplidyne fields F1-F2. | |
| R2 | Gen.Field Mod.Rect. | Supplies d-c for traction-generator field limit control. | |
| R3 | Gen.Field Mod.Rect. | Supplies d-c for traction-generator load limit control. | |

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| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| RC | Rev.Current Relay | Controls battery-charging contactor. | Coil Resistances<br>Shunt - 29.4 ohms<br>Diff. - 279 ohms<br>Series - .001 ohm |
| RH | Rev.Handle | Controls direction of loco. movement. | |
| SAR | Safety Relay | Opens governor clutch coil if speed coil circuit fails. | Tip Gap - 1/32 in.<br>Wipe - 1/32 in.<br>Coil Res. - 11.8 ohms<br>Pick-up - .35-.20<br>Drop-out - .070 |
| SCC | Capacitor | Part of field-shunting control panel. | 80 mfd. |
| SCD | Sensitive Relay | Part of field-shunting control panel. Down-shunting relay. | |
| SCU | Sensitive Relay | Part of field-shunting control panel. Up-shunting relay. | |

| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| SH | Selector Handle | Manually selects proper transition. Limits automatic transition, and controls dynamic braking. | |
| SMV | Shutter Magnet Valve | Controls air admission to shutter system. | |
| SR | Signal Relay | Energizes alarm gong circuits. | Tip Gap - 3/32 in.<br>Wipe - 1/32 in.<br>Coil Resis. - 11.8 ohms<br>Pick-up - .127 ± 5 percent<br>Drop-out - 15-35 percent |
| SW | Power Switch | Connects power circuit for dynamic braking. | Main Fingers<br>Tip Gap - 11-13/32 in.<br>Wipe - 7-9/32 in.<br>Lb. Pressure<br>Minimum - 35<br>Maximum - 45<br>Interlock Fingers<br>Tip Gap - 1-1 1/4 in.<br>Wipe - 1/8-1/4 in. |

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| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| S1 | Series Mtr. Contactor | Connects No. 1 and 3 motors in series. | Same as P1 |
| S21 | Series Mtr. Contactor | Connects No. 2 and 4 motors in series. | Same as P1 |
| TDR | Time Delay Relay | Delays opening of traction-motor contactors until excitation is removed. | Tip Gap - 1/32 in.<br>Wipe - 1/32 in.<br>Coil Resis. - 684 ohms<br>Pick-up - .045<br>Drop-out - 20-40 percent |
| TH | Throttle Handle | Controls power output of diesel engine. | |
| TR | Transfer Relay | Opens excitation circuits during transition. | Same as TDR. |
| T1 | Transformer | Supplies power for field circuit, field limit and current limit control. | |

| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| TB1-<br>TB2 | Trac.Motor Blower Motors | Furnish cooling air to traction motors. | 6-Pole, Commutating Pole, Series-wound, d-c Motors. |
| WS1-<br>WS2 | Wheel Slip Relays | Energizes buzzer, lights warning light if wheels slip. Idles engine in some cases. | Tip Gap - 1/32 in.<br>Wipe - 1/32 in.<br>Coil Resis. - .60 ohm<br>Pick-up - 2.5-2.6<br>Drop-out - 40-60 percent |
| X | Voltage Control Relay | Regulates voltage output of 75-volt auxiliary generator. | Coil Resistances<br>Compensating - 1.38 ohms<br>Operating - 7.20 ohms<br>Biasing - .662 ohm<br>Shunt - 10.22 ohms<br>Series - .21 ohm<br>Series - .0337 ohm<br>Stabilizing - 36.7 ohms |

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| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| X1 | Saturable Reactor | Current limit control. | |
| D1,D2 | | Varies a-c voltage in relation to CP voltage drop. | 54 turns, 0.091 ohm |
| D3,D4, | | Reference point for reactor operation. | 400 turns, 26 ohms |
| D5,D6 | | Increases control accuracy during dynamic braking. (Bootstrap effect.) | 50 turns, 0.860 ohm |
| X2 | Saturable Reactor | Supplies voltage to rectifier R3 to be applied to resistor 152. | |
| D1,D2 | | Reference point for reactor operation. | 2500 turns, 134 ohms |
| X3 | Saturable Reactor | Field limit control. | |
| D1,D2 | | Increases control accuracy. | 50 turns, 0.530 ohm |
| D3,D4 | | Varies a-c voltage across X4 in relation to current flowing in generator field. | 4 turns, 0.0023 ohm |

| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| X4 | Saturable Reactor | Supplies voltage to rectifier R2 to be applied to resistor 152. | |
| D1,D2 | | D-c reference point for reactor operation. | 2500 turns, 134 ohms |
| 100 | Battery & Train Line Switch | Connects battery to locomotive and train line circuits. | |
| 101 | Control Receptacle | For multiple-unit operation. | 21 point |
| 102 | Control Receptacle | For multiple-unit operation. | 12 point |
| 104 | Dynamic Brake Grids | Dynamic braking resistors. | Resistance between wires<br>R1-R8 - 2.24 ohms<br>R4-R5 - 2.24 ohms<br>R22-R23 - .818 ohm<br>R21-R28 - 2.50 ohms<br>R24-R25 - 2.24 ohms |

| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| 105 | Ammeter Shunt | Passes a fraction of main current through ammeter. | 1000 amp, 100 MV |
| 106 | Headlight Sw. | Controls headlight. | |
| 107 | Resistor | Traction-motor field-shunting resistor. | |
| 108 | Resistor | Resistance in series with BWR coil. | 2000 ohms* - 1500 ohms** |
| 110 | Tube Resis. | Discharge resistor for GS1 & GS2 coils. | 1500 ohms |
| 111 | Tube Resis. | To adjust loadmeter. | 5 ohms* - 4.4 ohms** |
| 112 | Grd.Relay Cutout Switch | When opened, ground relay GR will not operate. | |
| 113 | Tube Resis. | More field excitation for traction-motor blower generator A2 when using dynamic braking. | Wire 74-74C = 27.2 ohms<br>*Full value<br>**Approx. setting |

| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| 113 | Tube Resis. | Permits bright headlight operation. | Wire 60B-60C = 5.6 ohms |
| 113 | Tube Resis. | Permits dim headlight operation. | Wire 60A-60B = 5.9 ohms |
| 113A | Tube Resis. | Resistance in series with backup light. | 11.5 ohms |
| 114 | Capacitor | Stabilizes field of amplidyne in motoring. | 150 mfd |
| 115 | Capacitor | Stabilizes field of amplidyne in braking. | 500 mfd |
| 116 | Tube Resis. | Compensates for resistance change in field due to temperature. | .612 ohm |
| 116A | Tube Resis. | Control resistor in X1 reactor circuit. | 2-1 ohm* - 0.123 ohm** |
| 117 | Tube Resis. | Current limit control circuit adjustment. | 200 ohms* - 78/78 ohms**<br>*Full value<br>**Approx. setting |

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| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| 118 | Tube Resis. | Current limit control circuit adjustment. | 400 ohms*-114/177 ohms** |
| 118A | Tube Resis. | Current limit control circuit adjustment. | 2000 ohms* - 328/1485 ohms** |
| 119 | Tube Resis. | Eighth notch adjustment- current limit control. | 500 ohms* - 300 ohms** |
| 120 | Tube Resis. | Resistance in excitation field of amplidyne. | 25 ohms |
| 121 | Tube Resis. | Anticipation circuit shut-off. | 5000 ohms |
| 122 | Tube Resis. | Resistance in alternator field. | 3-4 ohms |
| 122A | Tube Resis. | Resistance in alternator field. | 3 ohms |
| 124 | Rheostat | Seventh and notch adjustment fuel limit control. | 500 ohms |
| 124A | Rheostat | Third and fourth notch adjustment fuel limit control. | 1000 ohms<br>*Full value<br>**Approx. setting |

| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| 125 | Rheostat | Controls excitation to maintain speed. | 17 ohms |
| 125A | Rheostat | Stabilizes action of gov. speed coil. | 118.5 ohms |
| 126 | Rectifier | Blocking rectifier for governor stabilizing coil. | |
| 126A | Rectifier | Blocking rectifier for governor stabilizing coil. | |
| 126B | Rectifier | Prevents energizing OPR before OPS2. | |
| 127 | Rheostat | Adjusts stabilizing circuit in governor. | 50 ohms |
| 127A | Rheostat | Adjusts stabilizing circuit in governor. | 1000 ohms |
| 127B | Rheostat | Adjusts stabilizing circuit in governor. | 50 ohms |
| 128 | Capacitor | Governor stabilizing. | 6-500 mfd |

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| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| 128A | Capacitor | For SAR coil. | 500 mfd |
| 129 | Tube Resis. | Stabilizing coil force-off. | 100 ohms |
| 130 | Rheostat | Fuel limit adjustment for CO. | 75 ohms |
| 131 | Rheostat | Replace resistance in fuel-limit coil circuit. | 175 ohms |
| 132 | Rheostat | Adjusts engine idle speed. | 35 ohms |
| 132A | Rheostat | Adjusts engine speed at 2nd notch. | 35 ohms |
| 132B | Rheostat | Adjusts engine speed at 3rd notch. | 35 ohms |
| 132C | Rheostat | Adjusts engine speed at 4th notch. | 35 ohms |
| 132D | Rheostat | Adjusts engine speed at 5th notch. | 25 ohms |

| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| 132E | Rheostat | Adjusts engine speed at 6th notch. | 25 ohms |
| 132F | Rheostat | Adjusts engine speed at 7th notch. | 25 ohms |
| 132G | Rheostat | Adjusts engine speed at 8th notch. | 35 ohms |
| 132H | Rheostat | Adjusts engine overspeed. | 50 ohms |
| 133 | Rectifier | Rectifies a-c of tachometer generator for operation of governor speed coil. | |
| 134 | Receptacle | Battery charging from external source. | |
| 135 | Voltmeter | Measuring battery voltage. | 0-100 volt |
| 136 | Cir.Brkrs. | Main control circuit breakers. | 150 amperes |

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| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| 137 | Cir.Brkr. | Auxiliary generator circuit breaker. | 200 amperes |
| 142 | Tube Resis. | Dropping resistors - signal lamps. | 300 ohms each |
| 142A | Tube Resis. | Dropping resistor - exhauster signal lamp. | 300 ohms |
| 142B | Tube Resis. | Dropping resistor - train control signal lamp. | 100 ohms (1500 RF) |
| 143 | Tube Resis. | Parallel with coil of SR for holding. | 25 ohms |
| 145 | Relay | Controls radiator-fan speed. | |
| 147 | Potentiometer | Commutates resistance for dynamic braking control. | 58.17 ohms |
| 148 | Capacitor | Stabilizes action of governor speed pilot coil. | 6-500 mfd |
| 149 | Ammeter & Shunt | Aux.generator ammeter and shunt. | 0-200 amp, 200 amp 50 MV |
| 150 | Receptacle | Standby power supply - train heating boiler. | |

| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| 151 | Capacitor | Stabilizes action of governor. | 500 mfd |
| 152 | Tube Resis. | Excitation for field (F1-F2) of amplidyne. | 2-25 ohms*-11.1 ohms ea** |
| 153 | Tube Resis. | 1st notch adjustment - current limit control excitation. | 1000-ohms* - 630 ohms** |
| 154 | Tube Resis. | Generator field limit control adjustment. | 1500-ohms* - 850 ohms** |
| 155 | Tube Resis. | Suicide circuit current limit adjustment of F3-F4 field of amplidyne. | 10 ohms |
| 156 | Tube Resis. | Generator load current-limit control, excitation circuit adjustment. | 1000-ohms* - 500 ohms** |
| 157 | Tube Resis. | Sensitivity adjustment for dynamic braking. | 3 ohms |
| 157A | Tube Resis. | Sensitivity adjustment for field limit control. | 3 ohms |
|  |  |  | *Full value<br>**Approx. setting |

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| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| 158 | Rectifier | Prevents feedback from 159 discharge. |  |
| 159 | Capacitor | Delays action of TDR operating coil. | 500 mfd |
| 161 | Rheostat | Adjusts fuel limit coil current in governor. | 50 ohms* - 35 ohms** |
| 162 | Cir.Brkr. | Aux.Generator (A1) field circuit breaker. | 15 amperes |
| 164 | Filter Reactor | Takes ripple out of d-c output of R1 rectifier. |  |
| 165 | Tube Resistor | Motor field current adjustment for dynamic braking. | 750 ohms* - 529 ohms** |
| 165A | Tube Resistor | Motor field current adjustment for dynamic braking. | 1000 ohms |
| 167 | Tube Resistor | Train line resistance for fuel pump contactor. | 10 ohms |
| 168 | Cir.Brkr. | Train control system circuit breaker. | 15 amperes |
|  |  |  | *Full Value<br>**Approx. setting |

| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| 169 | Cir.Brkr. | Master circuit breaker for fuel pumps. | 15 amperes |
| 170 | Switch | Controls fuel pump contactor. | |
| 171 | Cir.Brkr. | Engine crankcase exhauster circuit breaker. | 15 amperes |
| 172 | Cir.Brkr. | Motor-generator circuit breaker. | 70 amperes |
| 173 | Cir.Brkr. | Fuel pump circuit breaker. | 35 amperes |
| 174 | Switch | Radiator shutter limit switch - controls eddy-current clutch for radiator fan speed. | |
| 176 | Cir.Brkr. | Cab lights and auxiliaries circuit breaker. | 15 amperes |
| 177 | Rheostat | Controls cab heater and defroster. | |

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| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| 178 | Switches | Control number, class, hood and dome lights. | |
| 179 | Cir.Brkr. | Protects engine room light circuit. | 15 amperes |
| 180 | Cir.Brkr. | Protects headlight circuit. | 15 amperes |
| 181 | Cir.Brkr. | Protects control circuits. | 15 amperes |
| 182 | Switch | Controls compartment lights. | |
| 183 | Switch | Controls engine control panel light. | |
| 184 | Rheostat | Controls fireman's cowl lights. | 125 ohms |
| 185 | Panel | Controls black lights on engineman's panel. | |
| 186 | Receptacle | Back-up light receptacle. | |

| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| 187 | Cir.Brkr. | Protects propulsion control circuit. | 15 amperes |
| 188 | Mag.Valves | Control air pressure for sanding. | |
| 190 | Cir.Brkr. | Protects aux.generator (A2) field. | 15 amperes |
| 191 | Cir.Brkr. | Protects aux.generator (A2) armature. | 200 amperes |
| 192 | Cir.Brkr. | Protects train heat boiler circuits. (2000 hp). | 100 amperes |
| | Cir.Brkr. | Protects aux. generator (A2) armature (1500 hp). | |
| 193 | Tube Resis. | In TDR coil circuit. | 100 ohms |
| 194 | Capacitor | Across line switch. | 2 mfd |
| 195 | Resistor | Reduces voltage for indicator light on engineman's panel. | 75 ohms |

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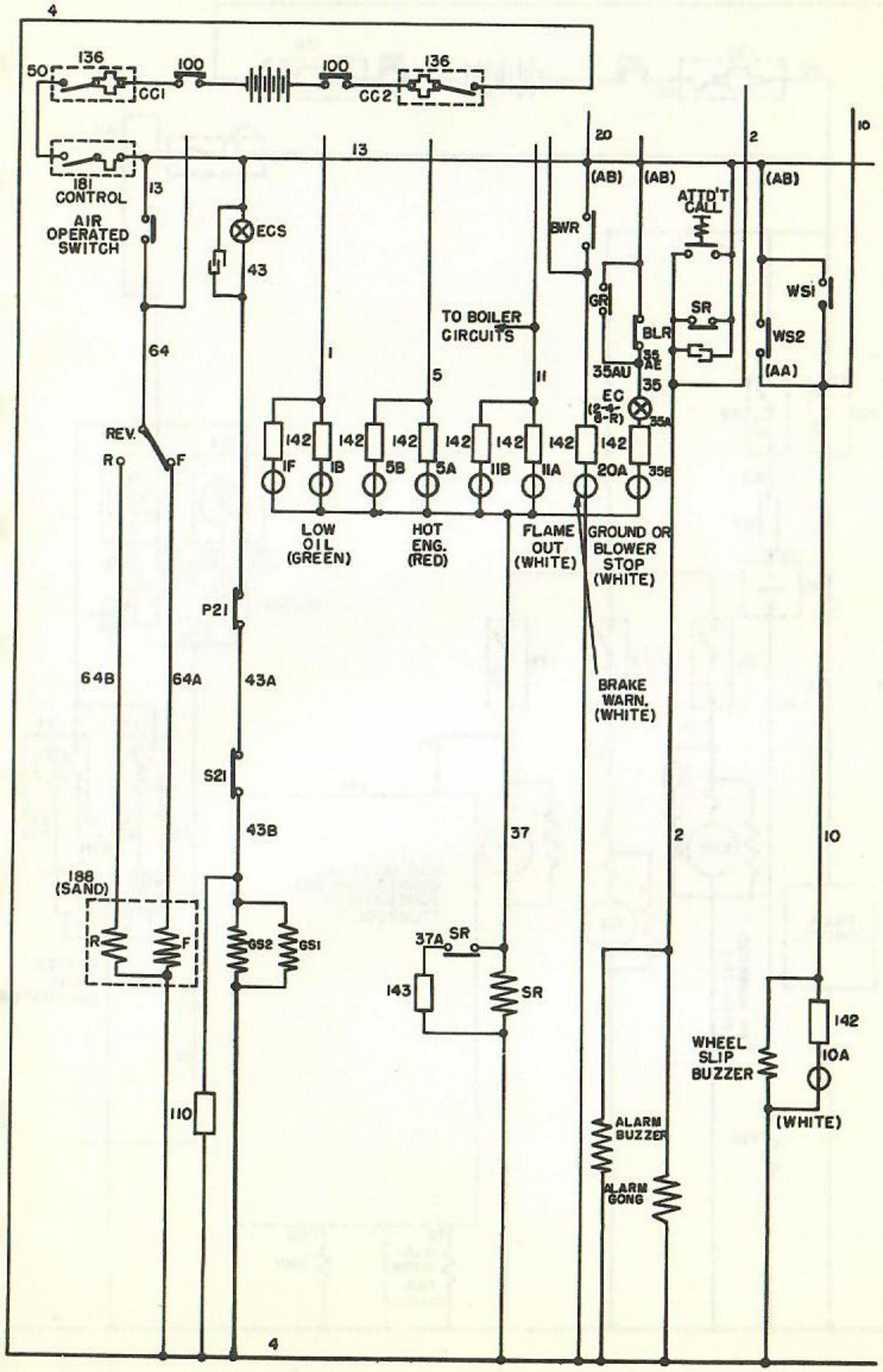
| SYMBOL | NAME | FUNCTION | DATA |
|---|---|---|---|
| 196 | Tube Resis. | Train line resistor. | 10 ohms |
| 197 | Tube Resis. | Discharge for DMR coil. | 1500 ohms |
| 198 | Tube Resis. | | 400 ohms |
| 200 | Shunt | Field-shunting control panel connection. | 3000 amp, 100 MV |
| | | SPECIALTIES | |
| S-16 | Interlock | Compressor governor interlock. | |
| WB1 | Valve | Compressor unloading valve. | |
| | Transf. | Standby lighting. | |

## NOTES

# SCHEMATIC WIRING DIAGRAMS

## ALARM CIRCUITS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CC1
100
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CC2
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CONTROL
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AIR
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SWITCH
ECS
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64
1
5
TO BOILER
CIRCUITS
11
20
(AB)
(AB)
BWR
GR
BLR
35
AE
35AU
35
EC
(2-4-
6-R)
35A
ATTD'T
CALL
SR
2
(AB)
WS1
WS2
(AA)
10
REV.
R
F
142
1F
142
1B
142
5B
142
5A
142
11B
142
11A
142
20A
142
35B
LOW
OIL
(GREEN)
HOT
ENG.
(RED)
FLAME
OUT
(WHITE)
GROUND OR
BLOWER
STOP
(WHITE)
BRAKE
WARN.
(WHITE)
P21
64B
64A
43A
S21
43B
37
2
10
188
(SAND)
R
F
GS2
GS1
37A
SR
143
SR
142
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(WHITE)
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ALARM
BUZZER
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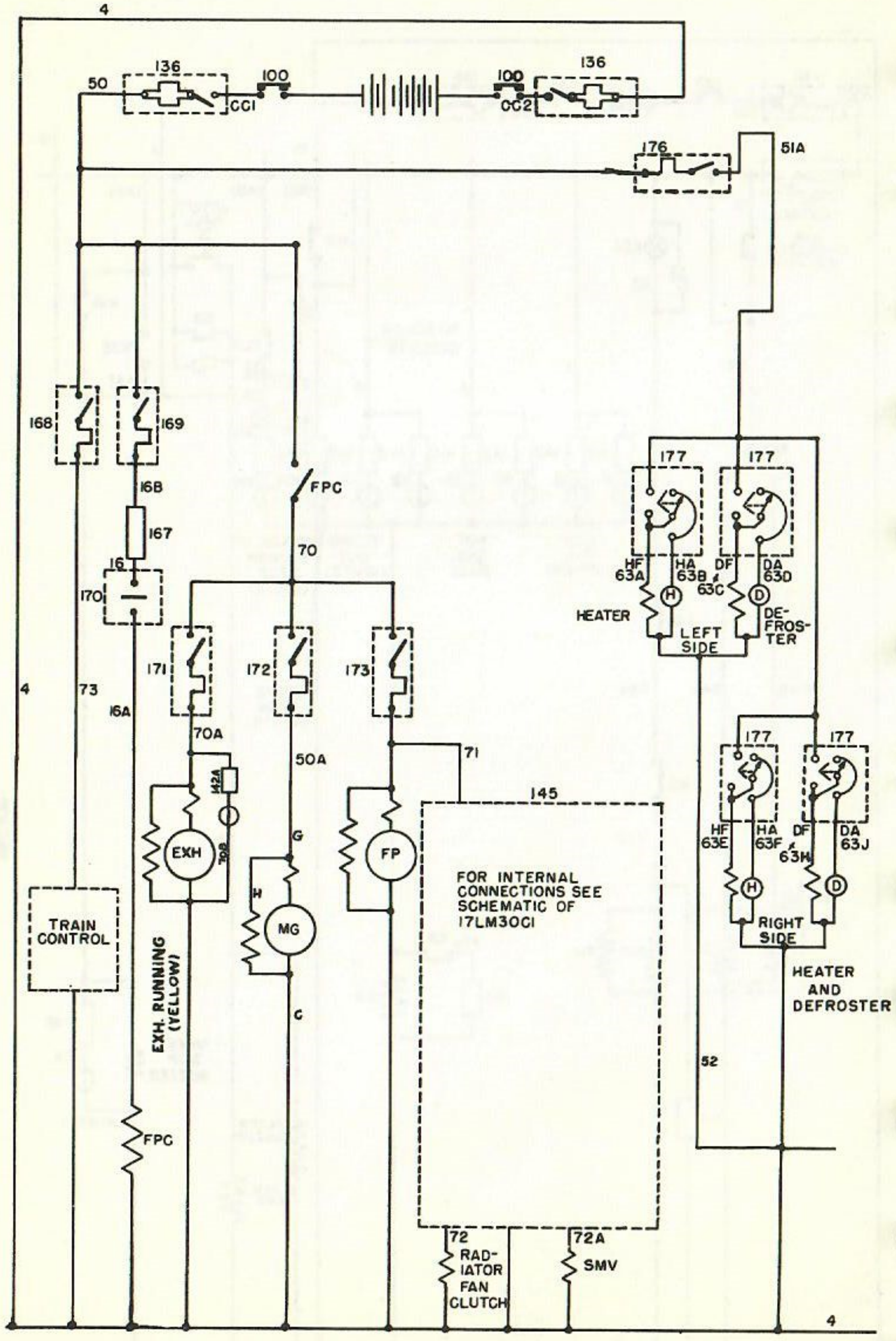
GONG
4

## AUXILIARIES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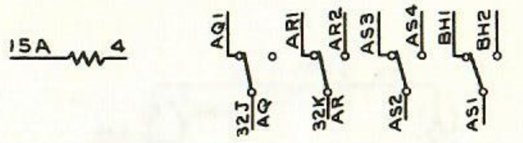
171
172
173
4
73
16A
70A
142A
142B
50A
71
145
EXH
G
FP
H
MG
C
FOR INTERNAL CONNECTIONS SEE SCHEMATIC OF 17LM30C1
TRAIN CONTROL
EXH. RUNNING (YELLOW)
FPC
72
RAD-IATOR FAN CLUTCH
72A
SMV
4
177
177
HF
63A
HA
63B
63C
DF
DA
63D
H
D
HEATER
LEFT SIDE
DE-FROS-TER
177
177
HF
63E
HA
63F
63H
DF
DA
63J
H
D
RIGHT SIDE
HEATER AND DEFROSTER
52

## AVF

AVF TYPE 17LV53C1 SEQUENCE RELAY

17LE34A3 PANEL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AR2
AS3
AS4
BH1
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AQ
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AR
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AS1

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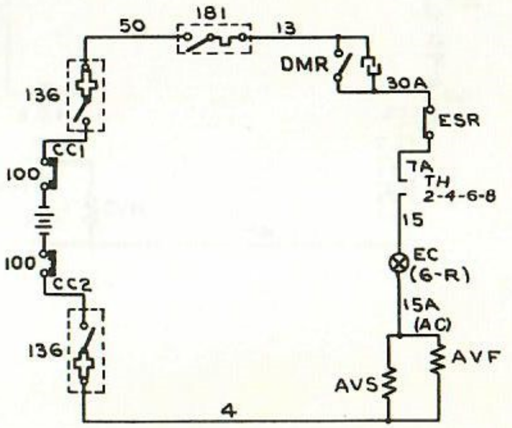
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15A
(AC)
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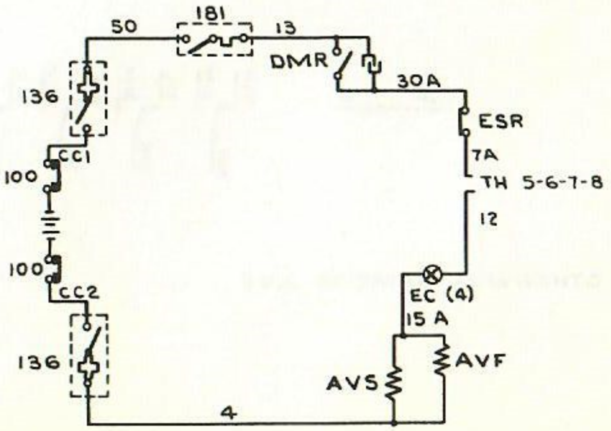
AVF
AVS
4

(b)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TH 5-6-7-8
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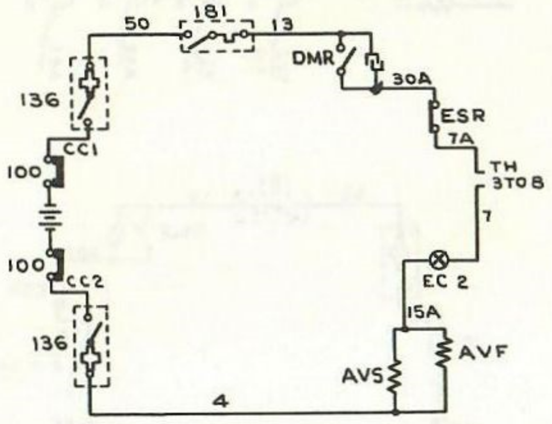
AVS
AVF
4

(CONT'D)

## AVF (Cont'd)
## AVS

(c)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7A
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EC 2
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AVS
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CC2
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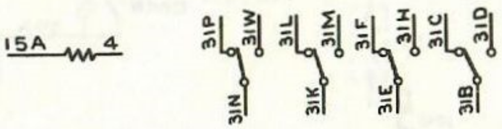
AVS TYPE 17LV53C1 SEQUENCE RELAY 17FM76B1 PANEL
REGULATES RESISTANCE IN GOVERNOR CIRCUITS


15A
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31P
31W
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31L
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31E
31C
31D
31B

OTHERWISE SAME AS AVF

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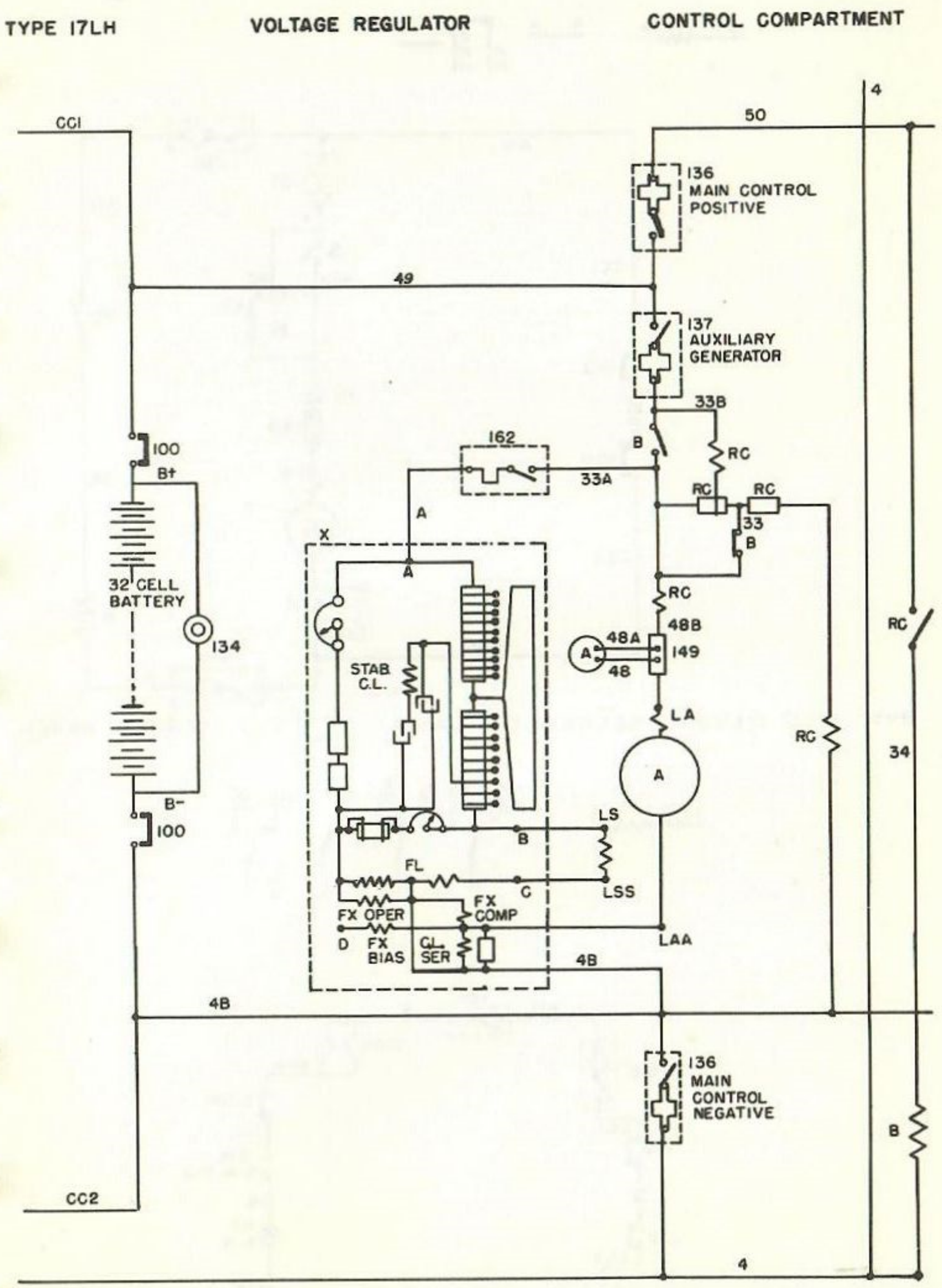
## BATTERY CHARGING CIRCUIT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137 AUXILIARY GENERATOR
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RC
162
33A
RC
RC
33
B
A
X
A
100
B+
32 CELL BATTERY
134
STAB C.L.
RC
48B
48A
48
149
LA
A
RC
RC
34
LS
B
FL
C
LSS
FX OPER
FX COMP
D
FX BIAS
CL SER
LAA
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B-
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CC2
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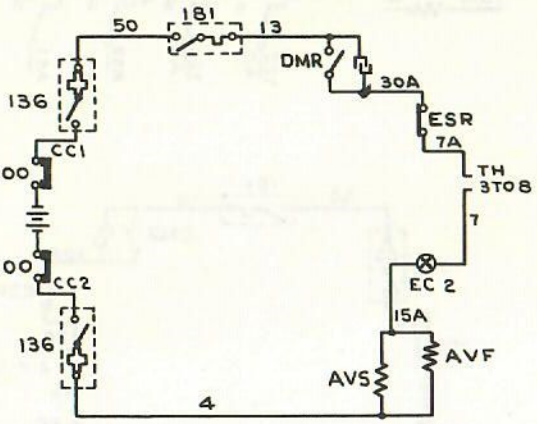
## AVF (Cont'd)
## AVS

(c)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AVS
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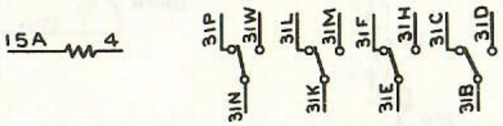
REGULATES RESISTANCE IN GOVERNOR CIRCUITS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31F
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31C
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31E
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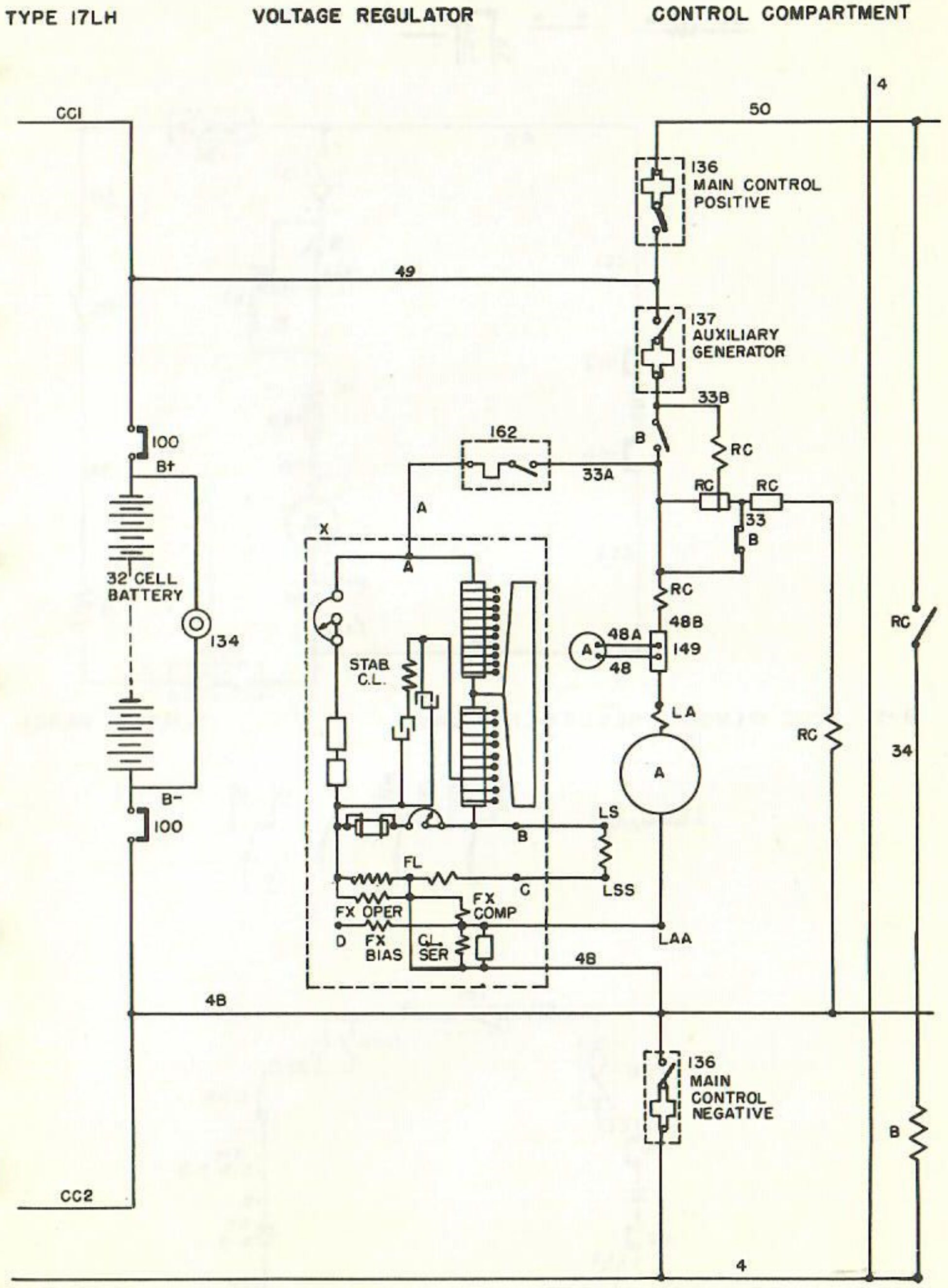
OTHERWISE SAME AS AVF

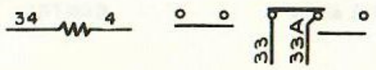
---

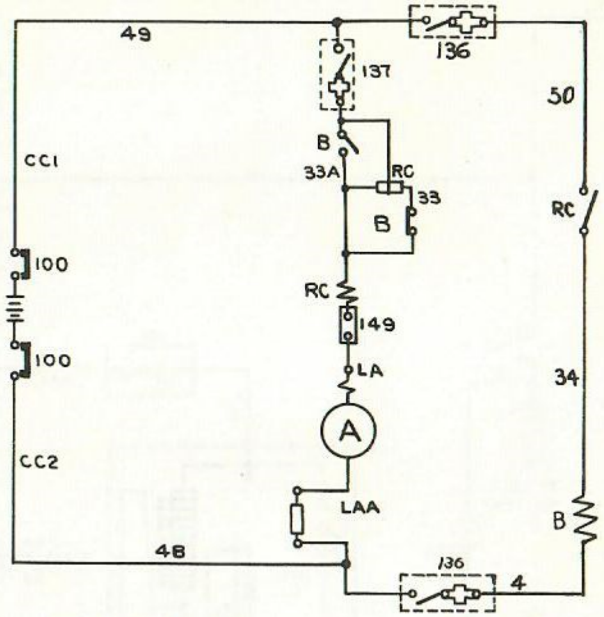
## BATTERY CHARGING CIRCUIT


TYPE 17LH
VOLTAGE REGULATOR
CONTROL COMPARTMENT
4
CC1
50
136
MAIN CONTROL
POSITIVE
49
137
AUXILIARY
GENERATOR
33B
100
B+
162
B
RC
33A
A
RC
RC
X
33
B
A
32 CELL
BATTERY
RC
48B
RC
134
STAB
C.L.
48A
149
48
LA
RC
34
A
B-
LS
100
B
FL
LSS
C
FX OPER
FX
COMP
D
FX
BIAS
CL
SER
LAA
48
48
136
MAIN
CONTROL
NEGATIVE
B
CC2
4

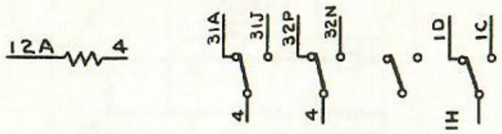
## B
## BVS

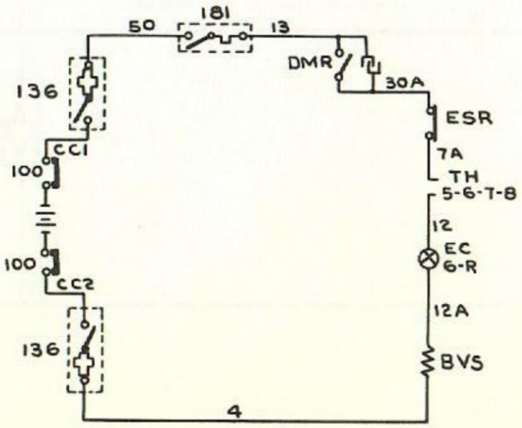
B TYPE 17CM15AV77 BATTERY CONTACTOR CONTROL COMPARTMENT




49
136
137
50
B
33A
RC
33
B
CC1
RC
100
100
RC
149
LA
34
A
CC2
LAA
B
48
136
4

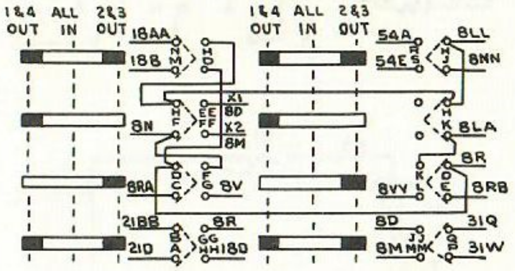
BVS TYPE 17LV53C1 SEQUENCE RELAY 17FM76B1 PANEL


12A
4
31A
31J
32P
32N
1D
1C
4
4
1H

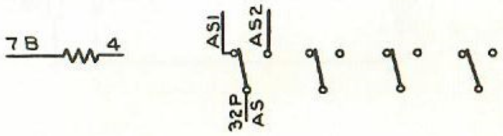

50
181
13
DMR
30A
136
ESR
CC1
7A
100
TH
5-6-7-8
12
EC
6-R
100
CC2
12A
136
BVS
4

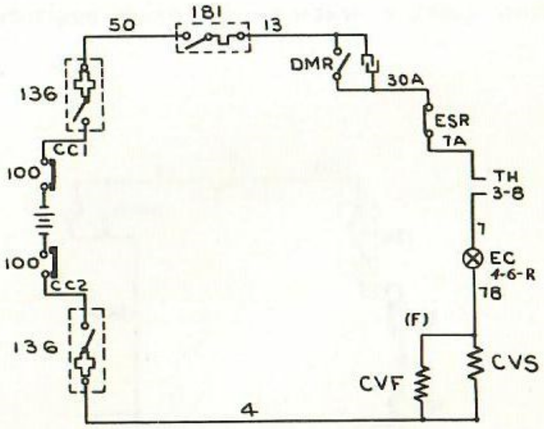
## CO
## CVF
## CVS

CO TYPE 17HC9B3 MOTOR CUT OUT SWITCH CONTROL COMPARTMENT

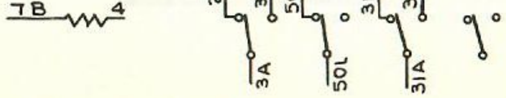

1&4 OUT
ALL IN
2&3 OUT
18AA
18B
N
M
H
D
X1
8D
H
F
EE
FF
X2
8M
8N
D
C
F
G
8RA
8V
21BB
21D
B
A
GG
HH
8R
18D
1&4 OUT
ALL IN
2&3 OUT
54A
54E
R
S
H
J
8LL
8NN
H
K
8LA
8R
K
L
D
E
8VV
8RB
8D
8M
JJ
MMK
Q
P
31Q
31W

CVF TYPE 17LV53C1 SEQUENCE RELAY 17LE34A3 PANEL


7B
4
AS1
AS2
32P
AS


50
181
13
DMR
30A
136
ESR
7A
CC1
100
TH
3-8
7
EC
4-6-R
100
7B
CC2
(F)
136
CVS
CVF
4

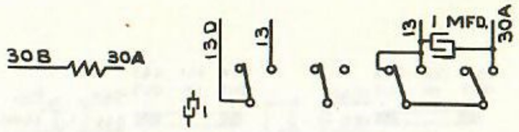
CVS TYPE 17LV53C1 SEQUENCE RELAY 17FM76B1 PANEL


7B
4
27
3B
50K
31B
31E
3A
50L
31A

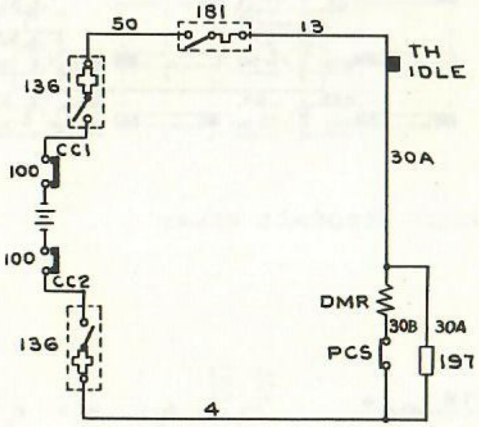
OTHERWISE SAME AS CVF

## DMR

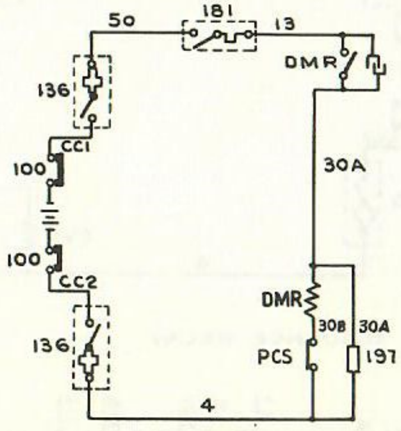
DMR TYPE 17LV53C901 DEADMANS RELAY CONTROL STAND


30B
30A
13D
13
1
13
1 MFD.
30A

(a)


50
181
13
TH IDLE
136
CC1
100
30A
100
CC2
DMR
30B
30A
PCS
197
136
4

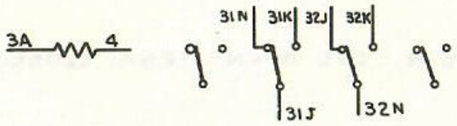
(b) HOLDING CIRCUIT WHEN TH IS IN OTHER POSITION THAN IDLE


50
181
13
DMR
136
CC1
100
30A
100
CC2
DMR
30B
30A
PCS
197
136
4

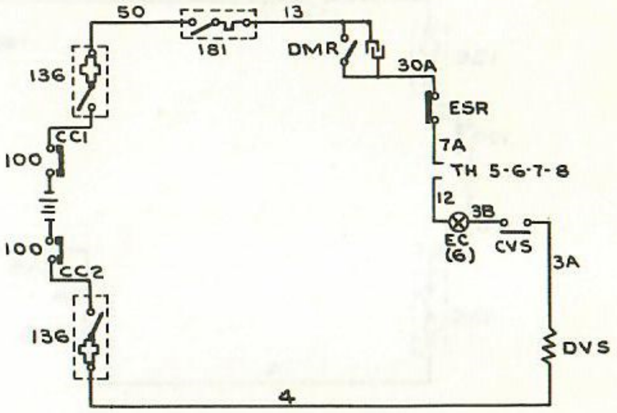
---

## DVS

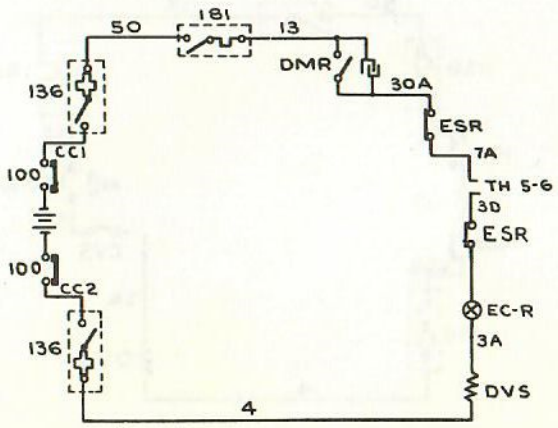
DVS TYPE 17LV53C1 SEQUENCE RELAY 17FM76B1 PANEL


3A
4
31N
31K
32J
32K
31J
32N

(a) EC IN 6, TH IN 5-6-7-8 AND CVS CLOSED


50
181
13
DMR
30A
136
ESR
CC1
100
7A
TH 5-6-7-8
12
3B
EC (6)
CVS
100
CC2
3A
136
DVS
4

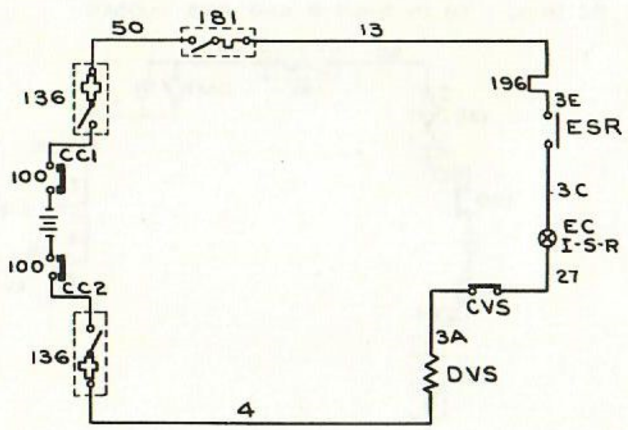
(b) EC IN R, TH IN 5-6


181
50
13
DMR
30A
136
ESR
CC1
7A
100
TH 5-6
3D
ESR
100
CC2
EC-R
3A
136
DVS
4

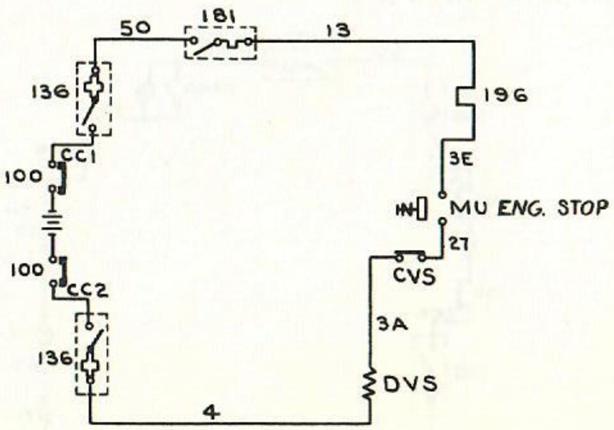
(CONT'D)

## DVS (Cont'd)

(C) EC IN I-S-R CVS OPEN ESR CLOSED


50
181
13
136
196
3E
ESR
CC1
100
3C
EC
I-S-R
100
27
CC2
CVS
3A
136
DVS
4

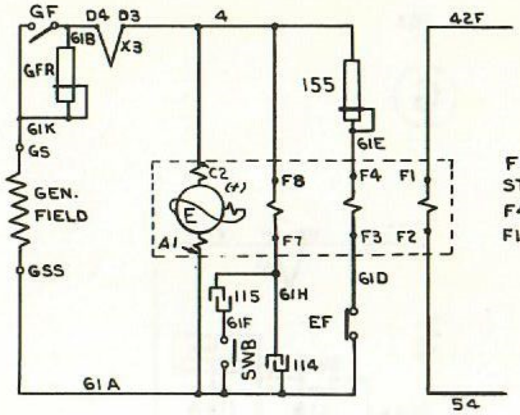
(D) MU-CLOSED CVS OPEN TH 1-2


50
181
13
136
196
CC1
3E
100
MU ENG. STOP
27
100
CVS
CC2
3A
136
DVS
4

---

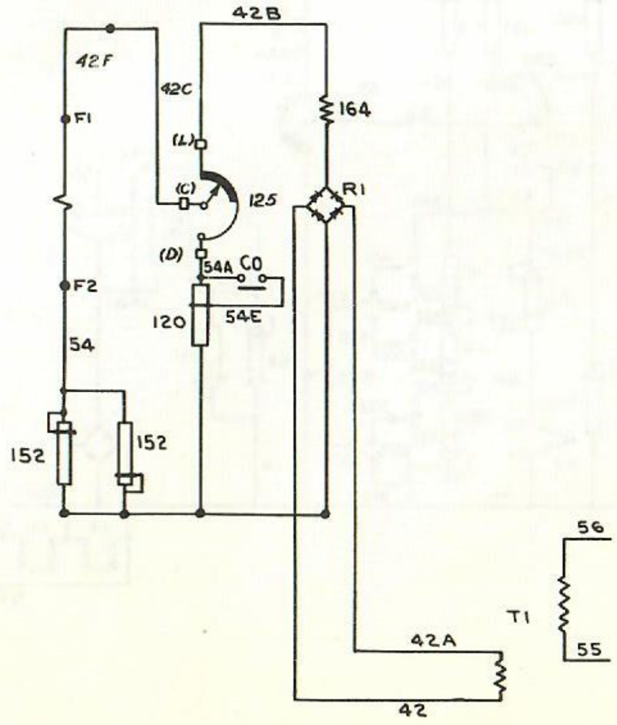
## E1, E2

E1 AMPLIDYNE EXCITER GENERATOR DRIVEN BY TRACTION GENERATOR, FURNISHES POWER FOR TRACTION GENERATOR SHUNT FIELD EXCITATION. CONTROLLED BY EXCITATION OF CONTROL FIELD BY FIELD CURRENT LIMIT, LOAD CURRENT LIMIT AND GOVERNOR SYSTEMS.


GF
D4 D3
4
42F
61B
X3
GFR
155
61K
GS
61E
C2
(+)
F8
F4
F1
GEN.
FIELD
E
A1
F7
F3
F2
GSS
115
61H
61D
61F
EF
SWB
114
61A
54

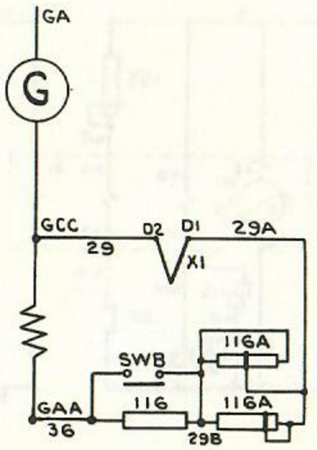
F8-F7- ANTI-HUNT OR STABILIZING FIELD
F4-F3- SUICIDE FIELD
F1-F2- MAIN CONTROL FIELD

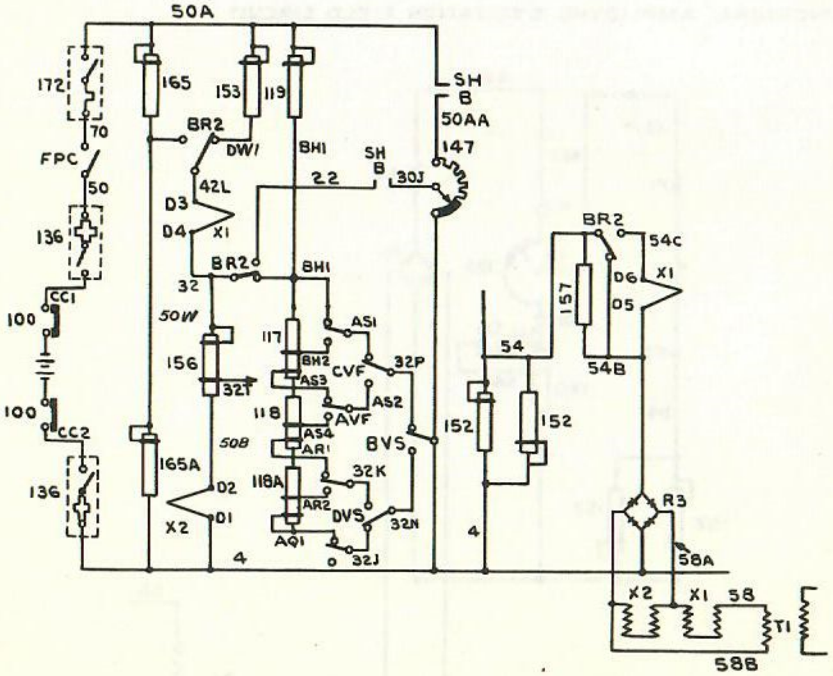
E2 NORMAL AMPLIDYNE EXCITATION FIELD CIRCUIT


42B
42F
42C
F1
164
(L)
(C)
125
R1
(D)
54A
CO
F2
54E
120
54
152
152
56
T1
42A
55
42

## E4

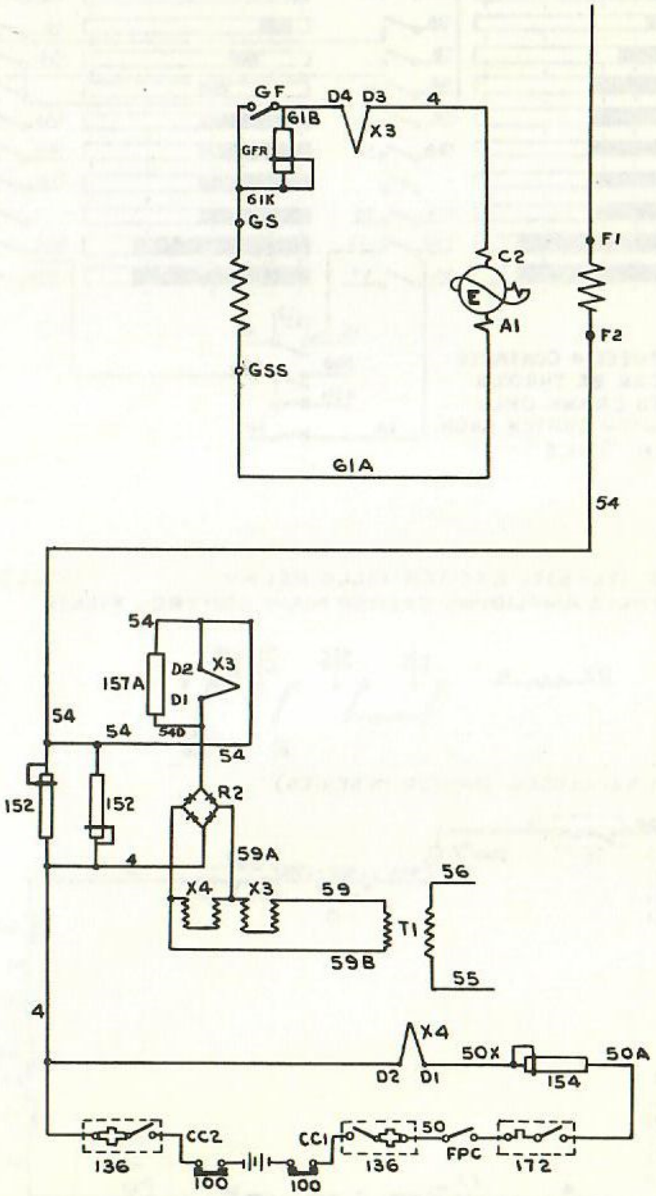
E4 CURRENT LIMIT CONTROL EXCITATION CIRCUITS


GA
G
GCC
29
D2
D1
29A
X1
SWB
116A
116
116A
GAA
36
29B

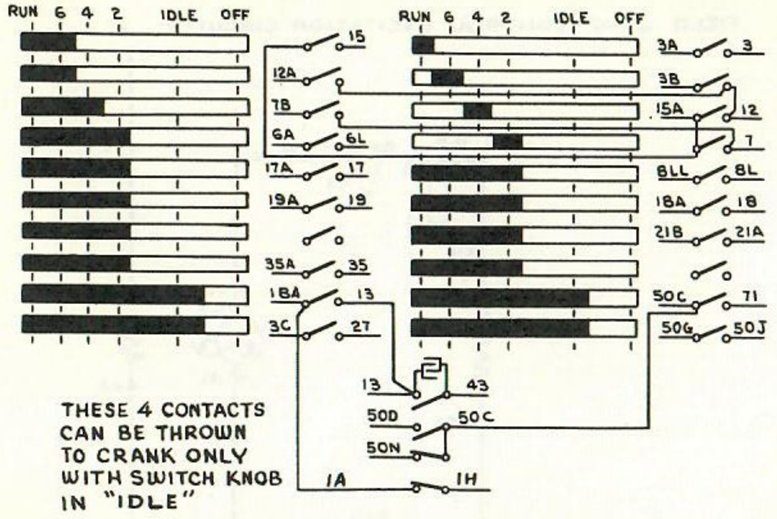

50A
172
165
153
119
SH
B
50AA
70
BR2
DW/
BH1
SH
B
147
FPC
50
42L
22
30J
D3
D4
X1
BR2
54C
136
BR2
BH1
D6
X1
32
D5
157
CC1
50W
117
AS1
100
BH2
32P
156
32T
AS3
CVF
54
54B
AS2
118
AVF
100
CC2
50B
AS4
BVS
152
152
AR1
165A
32K
136
D2
118A
AR2
DVS
R3
D1
32N
X2
AQ1
4
32J
4
58A
X2
X1
58
T1
58B

## E5

E5 FIELD LIMIT CONTROL EXCITATION CIRCUITS

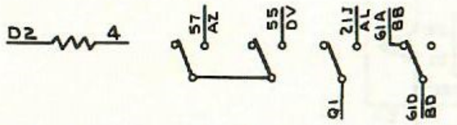

GF
D4
D3
4
61B
X3
GFR
61K
GS
F1
C2
E
A1
F2
GSS
61A
54
54
157A
D2
X3
D1
54
54
54D
54
152
152
R2
4
59A
56
X4
X3
59
T1
59B
55
4
X4
50X
50A
D2
D1
154
136
CC2
CC1
50
136
FPC
172
100
100

EC TYPE 17HC14A1 ENGINE CONTROL SWITCH 17FM76B1 PANEL

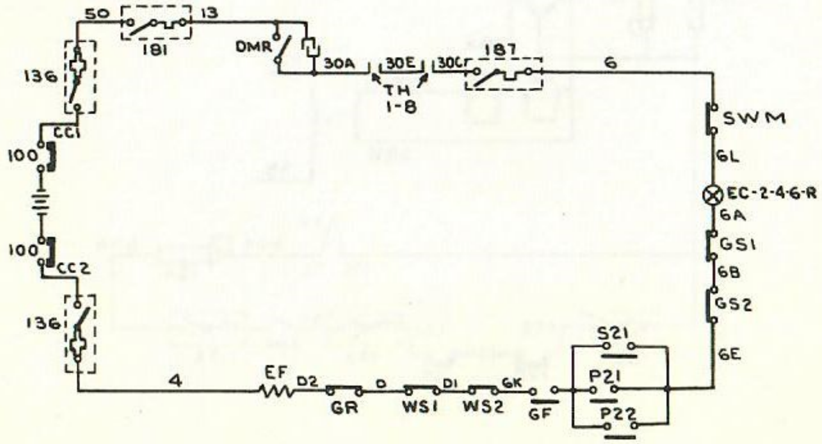

RUN
6
4
2
IDLE
OFF
15
12A
7B
6A
6L
17A
17
19A
19
35A
35
18A
13
3C
27
3A
3
3B
15A
12
7
8LL
8L
18A
18
21B
21A
50C
71
50G
50J
13
43
50D
50C
50N
1A
1H

THESE 4 CONTACTS
CAN BE THROWN
TO CRANK ONLY
WITH SWITCH KNOB
IN "IDLE"

EF TYPE 17LV53C1 EXCITER FIELD RELAY 17LE34A3 PANEL
CONTROLS AMPLIDYNE EXCITER MAIN CONTROL FIELD


D2
4
57
AZ
55
DV
21J
AL
61A
BB
Q1
61D
BD

(a) WITH S21 CLOSED (MOTOR IN SERIES)

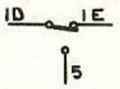

50
181
13
DMR
30A
30E
TH
1-8
30C
187
6
136
CC1
100
100
CC2
136
SWM
6L
EC-2-4-6-R
6A
GS1
6B
GS2
6E
S21
P21
P22
4
EF
D2
GR
D
WS1
D1
WS2
6K
GF

(b) P21 CLOSED (MOTORS 1 & 4 CUT-OUT)

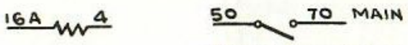
(c) P22 CLOSED (MOTORS 2&3 CUT-OUT)

---

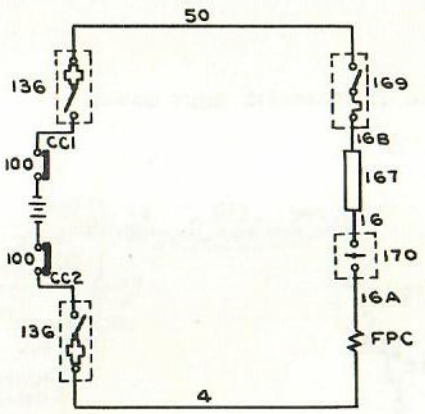
ETS TYPE #450FL1 ENGINE TEMPERATURE SWITCH 17FM76B1 PANEL
ENERGIZES HOT ENGINE WARNING LIGHT AND SR RELAY (CLOSES AT 185°F)



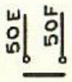
FPC TYPE 17CM15AL77 FUEL PUMP CONTACTOR CONTROL COMPARTMENT
ENERGIZES MOTOR OPERATED FUEL PUMP



MAIN CONTACTS (AUX.)
(NO INTERLOCKS)


50
136
CC1
100
100
CC2
136
169
16B
167
16
170
16A
FPC
4

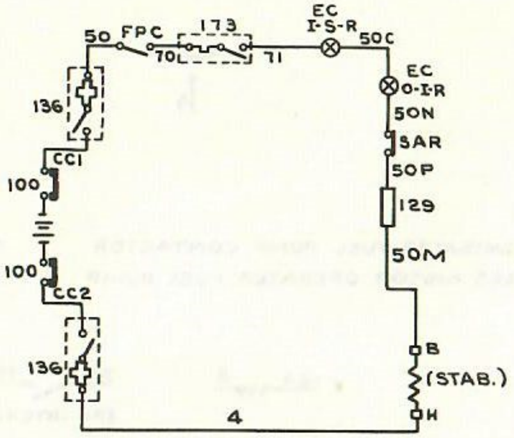
GOP TYPE #450 GOVERNOR OIL PRESSURE SWITCH 17FM76B1 PANEL
SHUTS DOWN ENGINE IN CASE GOVERNOR OIL PUMP FAILS
OPENS AT 75# CLOSES AT 80#



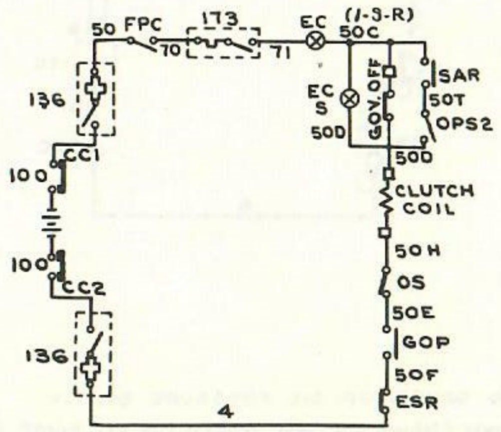
## GOV

GOV. TYPE 17MG3C1 ENGINE GOVERNOR REGULATES SPEED AND FUEL LIMIT OF DIESEL ENGINE — ON ENGINE

(a) BRINGING "A" AND "B" ARM TOGETHER


50
FPC
70
173
71
EC
I-S-R
50C
EC
O-I-R
50N
SAR
50P
129
50M
136
CC1
100
100
CC2
136
B
(STAB.)
H
4

(b) CLUTCH COIL (AUTOMATIC SHUT DOWN)

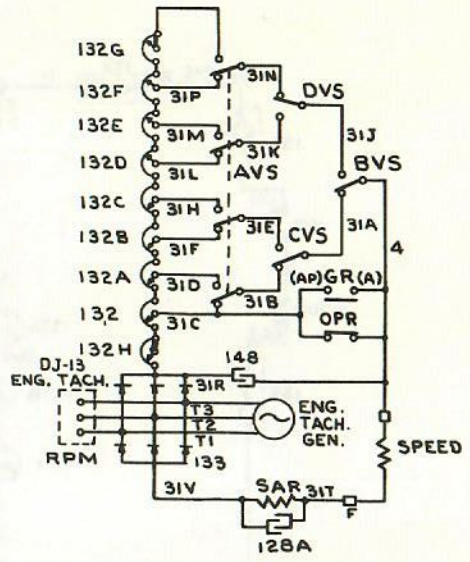

50
FPC
70
173
71
EC
(I-S-R)
50C
EC
S
50D
GOV-OFF
SAR
50T
OPS2
50D
CLUTCH COIL
50H
OS
50E
GOP
50F
ESR
136
CC1
100
100
CC2
136
4

(CONT'D)

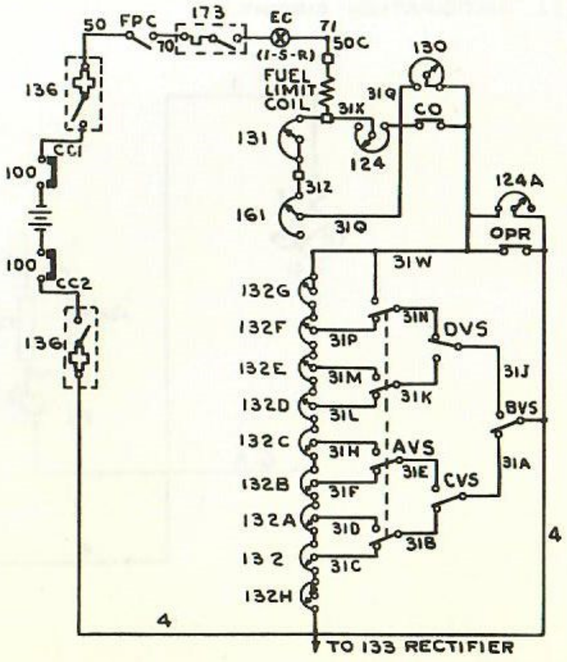
---

## GOV (Cont'd)

(c) SPEED COIL CIRCUIT


132G
132F
132E
132D
132C
132B
132A
132
132H
31N
31P
31M
31L
31H
31F
31D
31C
31K
31E
31B
DVS
31J
BVS
AVS
CVS
31A
4
(AP)GR(A)
OPR
148
DJ-13
ENG. TACH.
31R
T3
T2
T1
133
RPM
ENG. TACH. GEN.
SPEED
31V
SAR
31T
F
128A

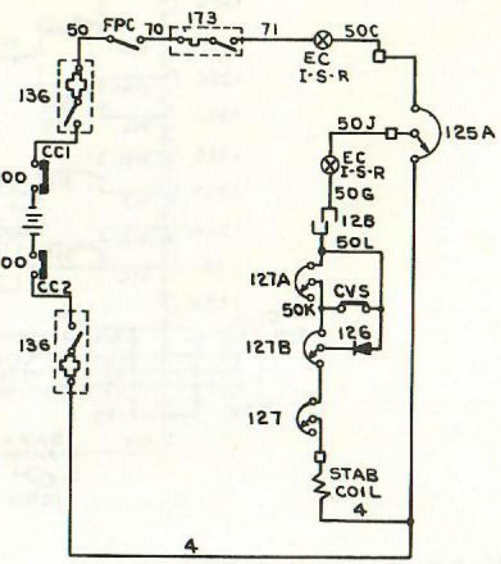
(d) FUEL LIMIT COIL CIRCUIT


50
FPC
70
173
EC
71
(I-S-R)
50C
130
FUEL LIMIT COIL
31X
31Q
CO
124
131
31Z
161
31Q
124A
OPR
31W
136
CC1
100
100
CC2
136
132G
132F
132E
132D
132C
132B
132A
132
132H
31N
31P
31M
31L
31H
31F
31D
31C
31K
31E
31B
DVS
31J
BVS
AVS
CVS
31A
4
4
TO 133 RECTIFIER

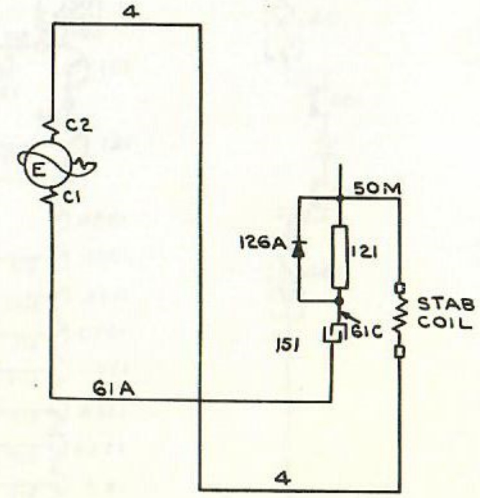
(CONT'D)

## GOV (Cont'd)

(e) STABILIZING CIRCUIT


50
FPC
70
173
71
50C
EC
I-S-R
136
CC1
100
100
CC2
136
50J
125A
EC
I-S-R
50G
128
50L
127A
CVS
50K
126
127B
127
STAB
COIL
4
4

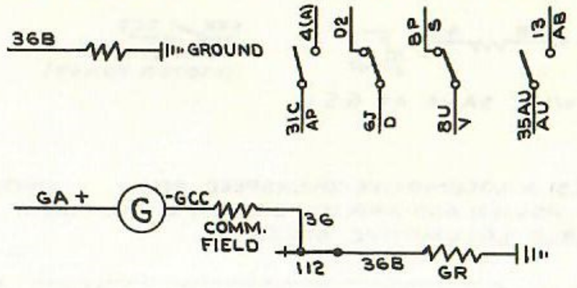
(f) ANTICIPATION CIRCUIT


4
C2
E
C1
50M
126A
121
STAB
COIL
151
61C
61A
4

---

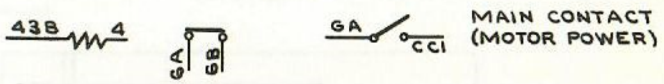
## GR
## GS1

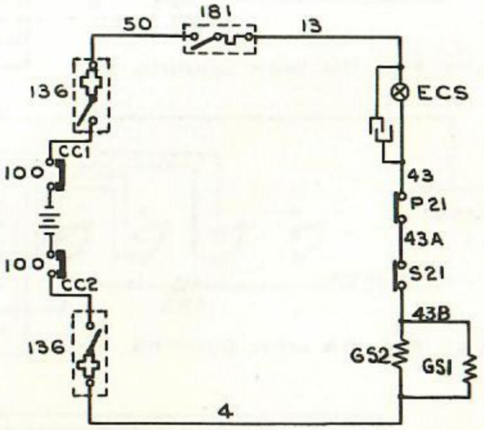
GR TYPE 17LV53L25 GROUND RELAY DE-ENERGIZES 17LE34A3 PANEL IN CASE OF A GROUND ON POWER CIRCUITS FIELD CIRCUIT OF TRACTION GENERATOR, IDLES ENGINE, OPERATES WARNING BELL AND LIGHT


36B
GROUND
4(A)
31C AP
D2
6J D
BP S
8U V
13 AB
35AU AU
GA +
G
-GCC
COMM.
FIELD
36
112
36B
GR

GS1 TYPE 17CM43C1 CRANKING CONTACTOR CONTROL COMPARTMENT

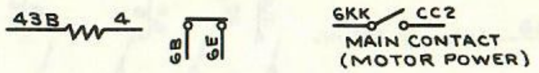
CONNECTS TRACTION GENERATOR THROUGH STARTING WINDING TO BATTERY FOR CRANKING ENGINE


43B
4
6A
6B
GA
CC1
MAIN CONTACT
(MOTOR POWER)


50
181
13
136
ECS
CC1
100
43
P21
43A
100
S21
CC2
43B
136
GS2
GS1
4

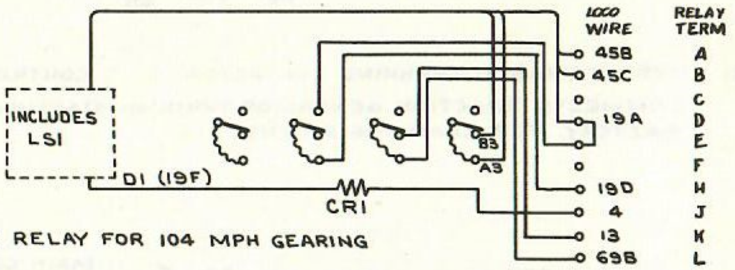
## GS2
## LOS

GS2 TYPE 17CM43C1 CRANKING CONTACTOR CONTROL COMPARTMENT
CONNECTS TRACTION GENERATOR THROUGH STARTING WINDING TO BATTERY FOR CRANKING ENGINE

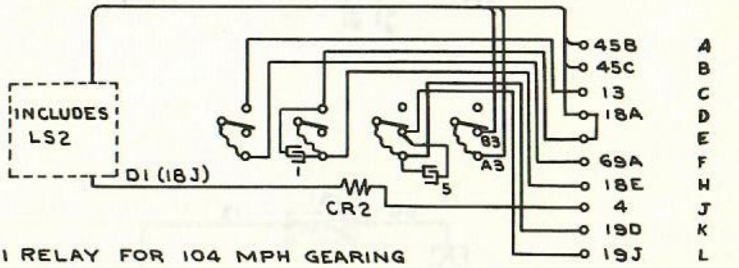

43B
4
6B
6E
6KK
CC2
MAIN CONTACT
(MOTOR POWER)

OTHERWISE SAME AS GS1

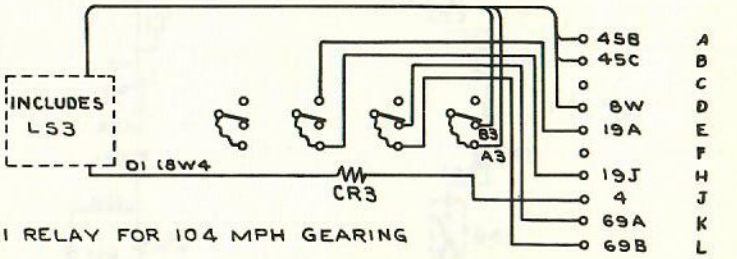
LOS TYPE 17LE51 A LOCOMOTIVE OVERSPEED RELAY CONTROL STAND
REMOVES POWER AND APPLIES BRAKES AT MAXIMUM PERMISSABLE LOCOMOTIVE SPEED


LOCO WIRE
RELAY TERM
INCLUDES LS1
D1 (19F)
CR1
B3
A3
45B A
45C B
C
19A D
E
F
19D H
4 J
13 K
69B L

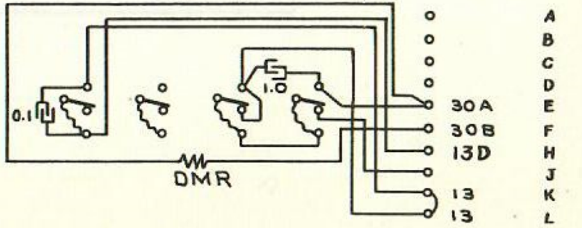
17LE41B1 RELAY FOR 104 MPH GEARING


INCLUDES LS2
D1 (18J)
CR2
1
5
B3
A3
45B A
45C B
13 C
18A D
E
69A F
18E H
4 J
19D K
19J L

17LE41D1 RELAY FOR 104 MPH GEARING


INCLUDES LS3
D1 (8W4
CR3
B3
A3
45B A
45C B
C
8W D
19A E
F
19J H
4 J
69A K
69B L

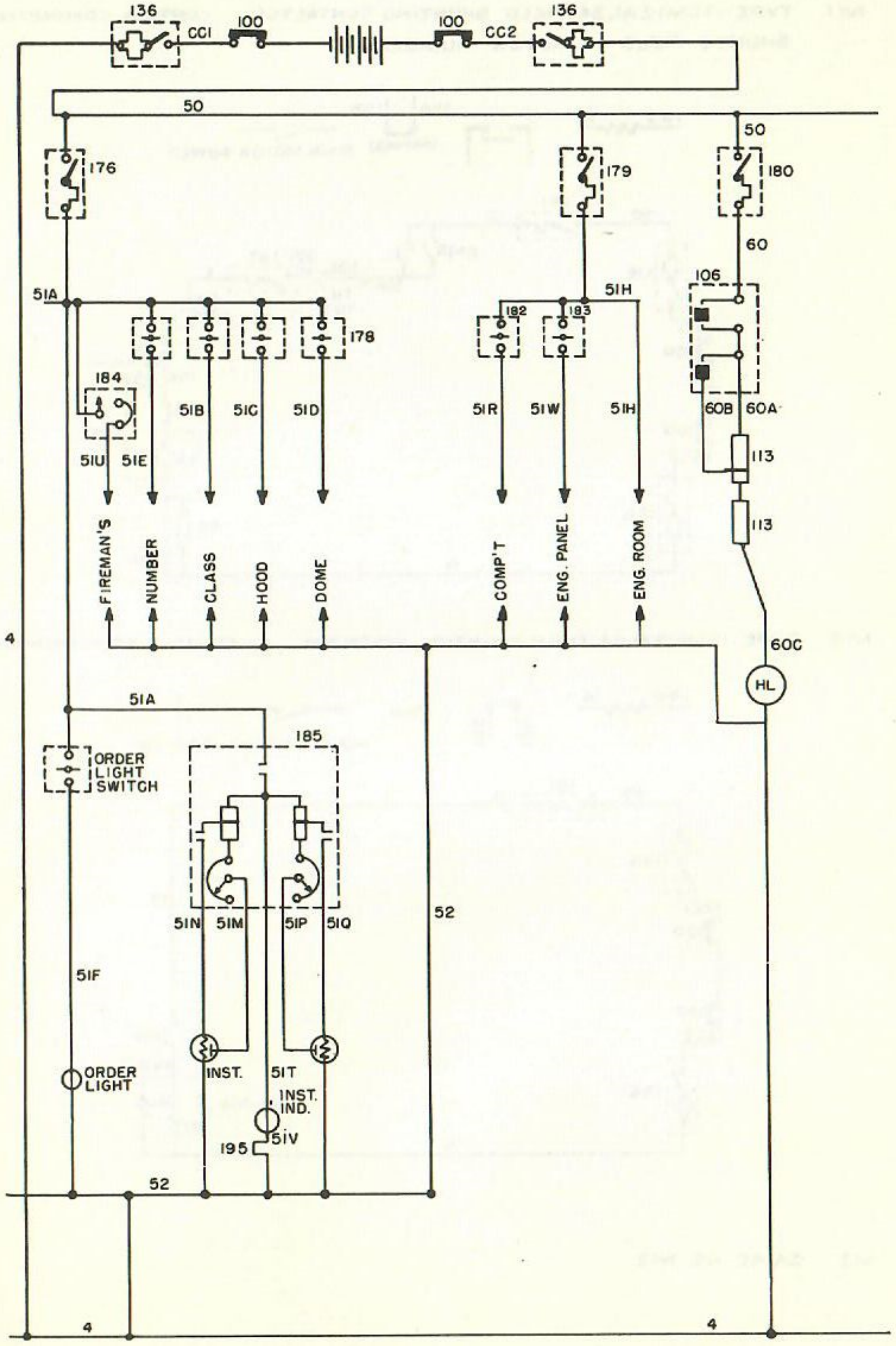
17LE41E1 RELAY FOR 104 MPH GEARING


0.1
1.0
DMR
A
B
C
D
30A E
30B F
13D H
J
13 K
13 L

17LE51A1

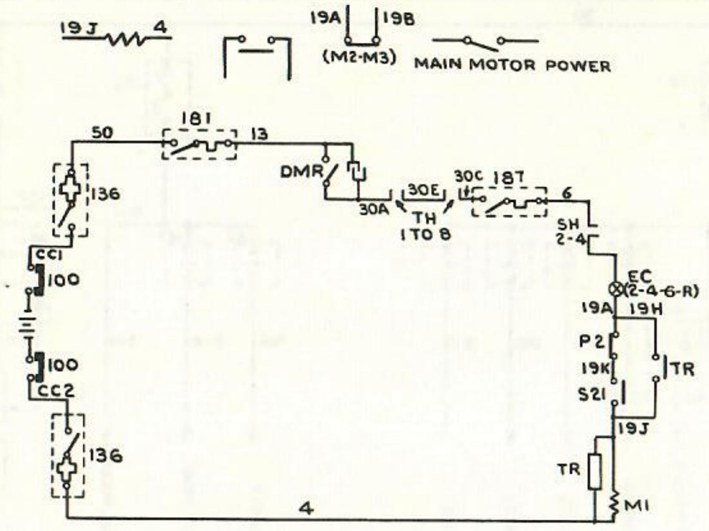
---

## LIGHTING CIRCUITS

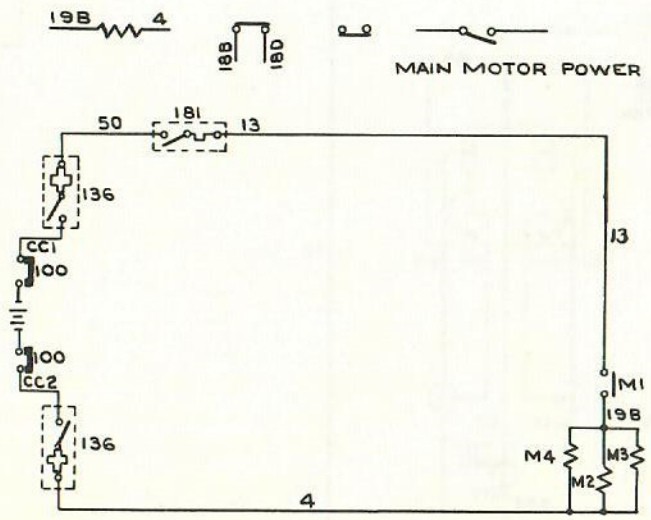

136
CC1
100
100
CC2
136
50
50
176
179
180
60
106
51A
51H
182
183
178
184
51B
51C
51D
51R
51W
51H
60B
60A
51U
51E
113
113
FIREMAN'S
NUMBER
CLASS
HOOD
DOME
COMP'T
ENG. PANEL
ENG. ROOM
4
60C
HL
51A
185
ORDER LIGHT SWITCH
51N
51M
51P
51Q
52
51F
ORDER LIGHT
INST.
51T
INST. IND.
195
51V
52
4
4

## M1, M2
## M3, M4

M1 TYPE 17CM12AL34 FIELD SHUNTING CONTACTOR CONTROL COMPARTMENT
SHUNTS FIELD OF MOTOR NUMBER 1.


19J
4
19A
19B
(M2-M3)
MAIN MOTOR POWER
50
181
13
136
DMR
30A
30E
30C
187
6
TH
1 TO 8
SH
2-4
CC1
100
EC
(2-4-6-R)
19A
19H
100
CC2
P2
19K
S21
TR
19J
136
TR
4
M1

M2 TYPE 17MC12AL34 FIELD SHUNTING CONTACTOR CONTROL COMPARTMENT

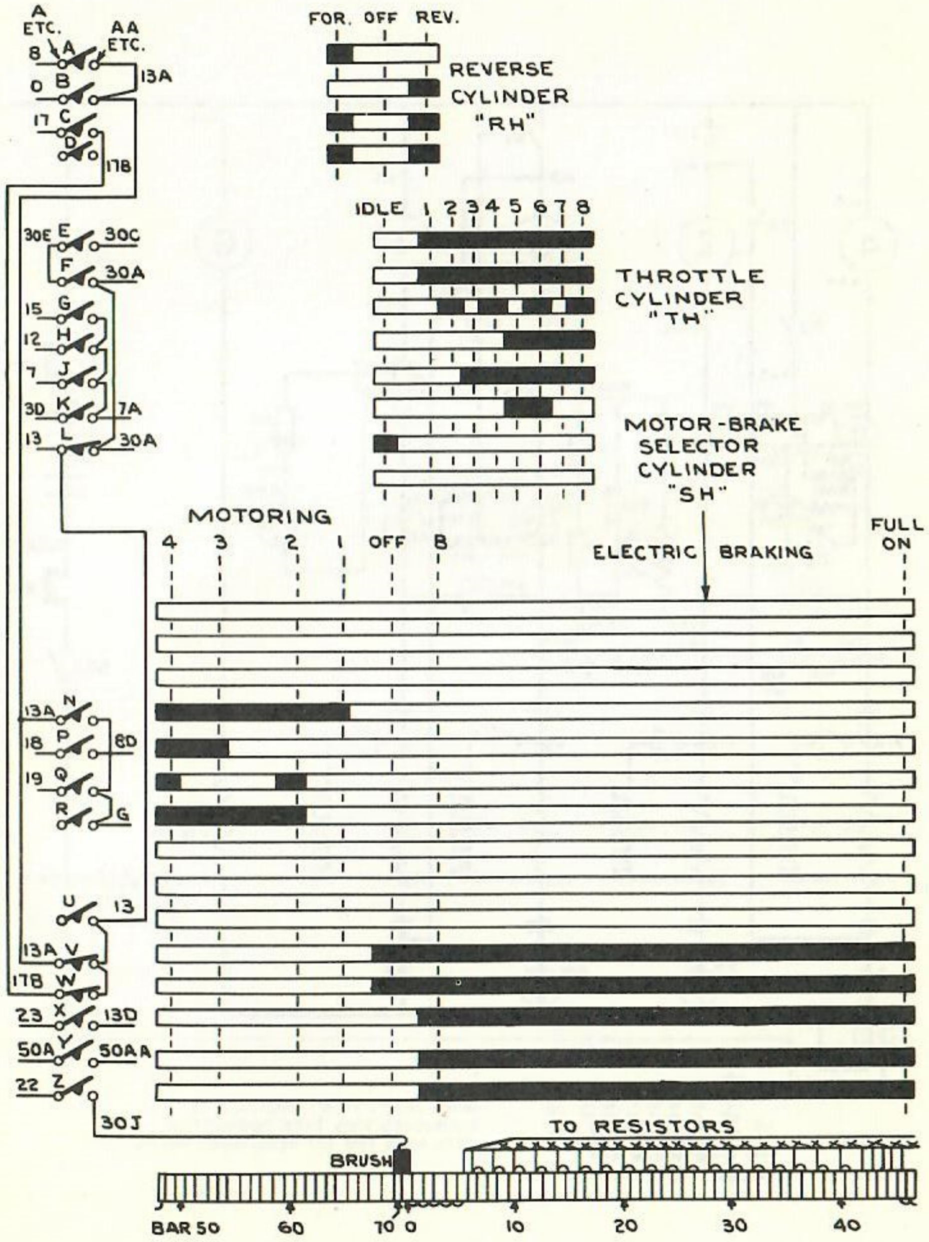

19B
4
18B
18D
MAIN MOTOR POWER
50
181
13
136
13
CC1
100
100
CC2
M1
19B
136
M4
M3
M2
4

M3 SAME AS M2

M4 SAME AS M2

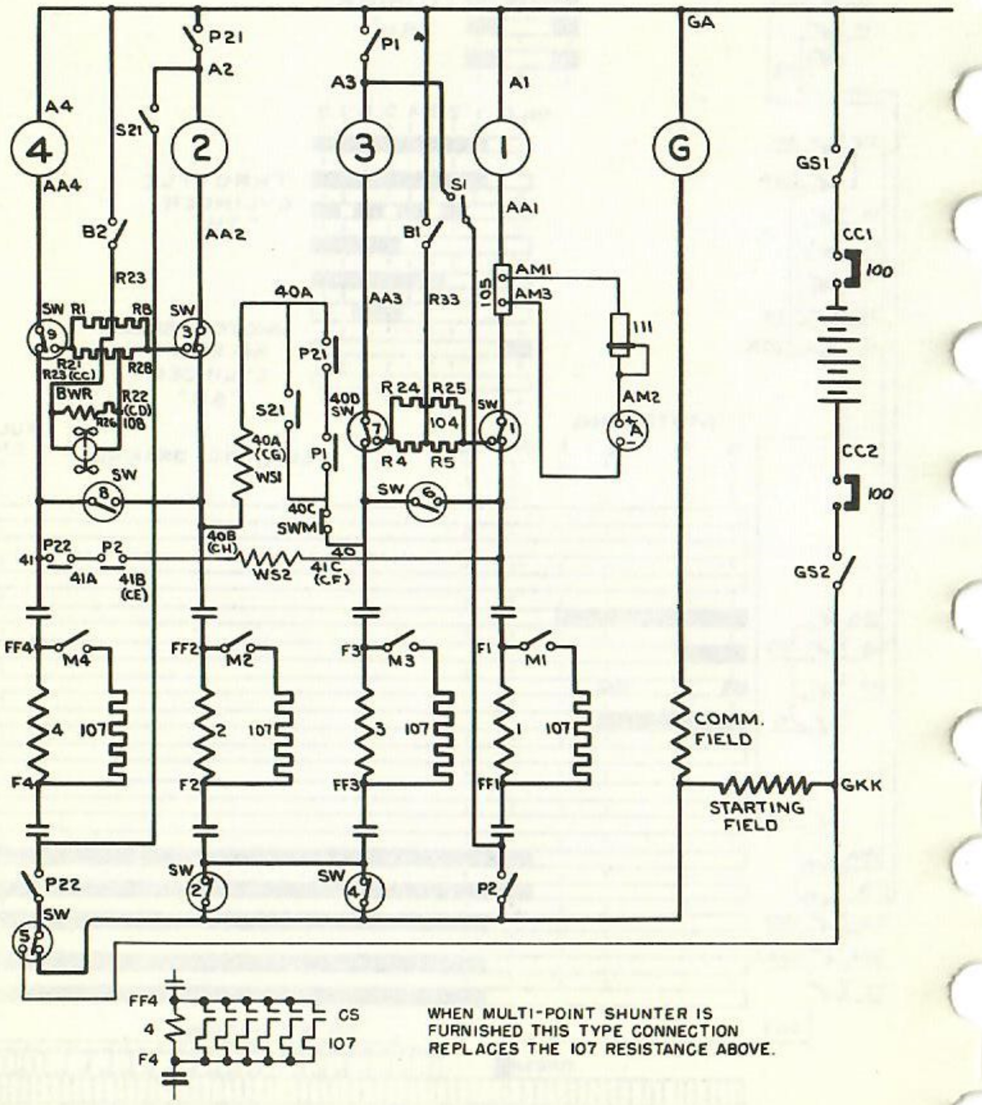
## MASTER CONTROLLER

TYPE 17KC66F1 MASTER CONTROLLER CONTROL STAND


A ETC.
AA ETC.
8
A
B
13A
0
17
C
D
17B
FOR.
OFF
REV.
REVERSE CYLINDER "RH"
IDLE
1 2 3 4 5 6 7 8
30E
E
30C
F
30A
15
G
12
H
7
J
3D
K
7A
13
L
30A
THROTTLE CYLINDER "TH"
MOTOR-BRAKE SELECTOR CYLINDER "SH"
MOTORING
4
3
2
1
OFF
B
ELECTRIC BRAKING
FULL ON
13A
N
18
P
8D
19
Q
R
G
U
13
13A
V
17B
W
23
X
13D
50A
Y
50AA
22
Z
30J
TO RESISTORS
BRUSH
BAR 50
60
70
0
10
20
30
40

## POWER CIRCUITS

TRACTION MOTOR, TRACTION GENERATOR, ENGINE STARTING POWER CIRCUITS


GA
P21
A2
P1
A3
A1
A4
S21
4
2
3
1
G
GS1
AA4
S1
AA1
B2
AA2
B1
CC1
100
R23
40A
AA3
R33
105
AM1
AM3
111
SW R1
R8
SW
9
3
R21
R23(CC)
R28
P21
BWR
R22 (CD)
R26
108
S21
400 SW
R24 R25
104
SW
7
1
AM2
A
40A (CG)
WS1
P1
R4 R5
SW
8
SW
6
CC2
100
40C
SWM
40B (CH)
41
P22
P2
41A
41B (CE)
WS2
40
41C (CF)
GS2
FF4
M4
FF2
M2
F3
M3
F1
M1
4 107
2 107
3 107
1 107
COMM. FIELD
F4
F2
FF3
FF1
STARTING FIELD
GKK
P22
SW
2
SW
4
P2
SW
5
FF4
4
F4
CS
107

WHEN MULTI-POINT SHUNTER IS FURNISHED THIS TYPE CONNECTION REPLACES THE 107 RESISTANCE ABOVE.

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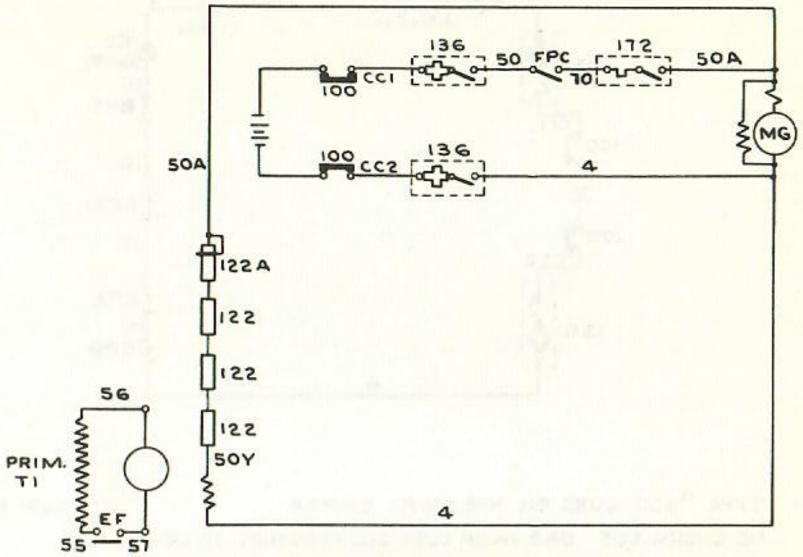
**MG**
**OPR**

MG 400 CYCLE MOTOR ALTERNATOR SET AISLE ON A SIDE

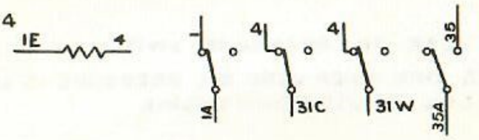
FURNISHES POWER FOR T1

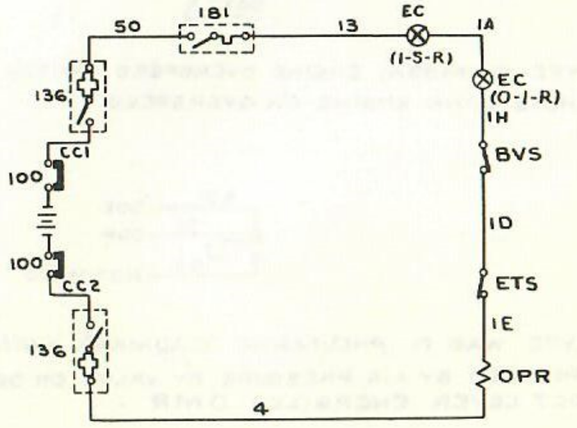

136
50
FPC
172
50A
CC1
100
10
MG
50A
100
CC2
136
4
122A
122
122
56
122
PRIM. T1
50Y
EF
55
57
4

OPR TYPE 17LV53C1 OIL PRESSURE CONTROL RELAY 17FM76B1 PANEL

IN CASE OF LOW LUBE OIL PRESSURE, REDUCES LOAD ON ENGINE, ENERGIZES WARNING LIGHT AND BELL

(a) TH-1-2-3-4

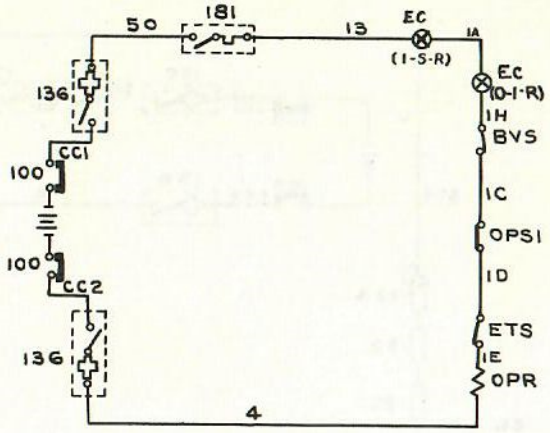

1E
4
4
4
35
1A
31C
31W
35A


50
181
13
EC
(1-5-R)
1A
EC
(0-1-R)
1H
136
CC1
BVS
100
1D
100
CC2
ETS
1E
136
OPR
4

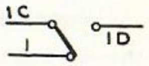
(CONT'D)

# Governor Clutch
# OPS1, OPS2
# OS, PCS

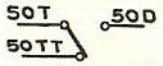
(b) TH-5-6-7-8


50
181
13
EC
(1-5-R)
1A
EC
(0-1-R)
1H
BVS
1C
OPS1
1D
ETS
1E
OPR
136
CC1
100
100
CC2
136
4

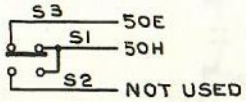
OPS1 TYPE #450 LUBE OIL PRESSURE SWITCH 17FM76B1 PANEL
DE-ENERGIZES OPR WHEN LUBE OIL PRESSURE IS LOW AT HIGH SPEED OPENS AT 20 LBS.



OPS2 TYPE #450 LUBE OIL PRESSURE SWITCH 17FM76B1 PANEL
DE-ENERGIZES OPR WHEN LUBE OIL PRESSURE IS LOW
OPENS AT 7 LBS. SHUTS DOWN ENGINE

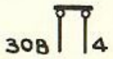

50T
50D
50TT

OS TYPE 17HM30A1 ENGINE OVERSPEED SWITCH
SHUTS DOWN ENGINE ON OVERSPEED


S3
50E
S1
50H
S2
NOT USED

SEE GOVERNOR

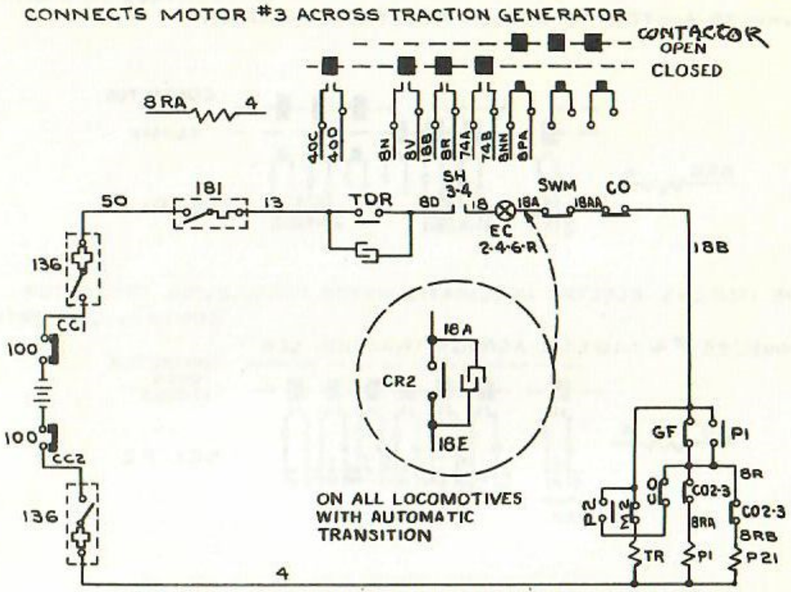
PCS TYPE WAB-F1 PNEUMATIC DEADMAN'S SWITCH HOOD NOSE
OPERATED BY AIR PRESSURE BY VALVE ON DEADMANS FOOT LEVER ENERGIZES DMR



---

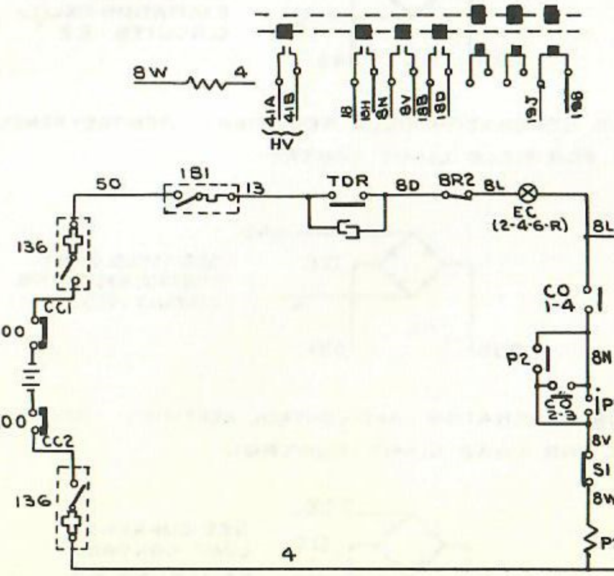
# P1, P2

P1 TYPE 17CP2N3 MOTOR PARALLELING ELECTRO-PNEUMATIC CONTACTOR CONTROL COMPARTMENT
CONNECTS MOTOR #3 ACROSS TRACTION GENERATOR


CONTACTOR
OPEN
CLOSED
8RA
4
40C
40D
8N
8V
18B
8R
74A
74B
8NN
8PA
50
181
13
TDR
8D
SH
3-4
18
18A
SWM
18AA
CO
EC
2-4-6-R
18B
136
CC1
100
100
CC2
136
18A
CR2
18E
ON ALL LOCOMOTIVES WITH AUTOMATIC TRANSITION
GF
P1
8R
P2
CO
CO2-3
8RA
CO2-3
8RB
TR
P1
P21
4

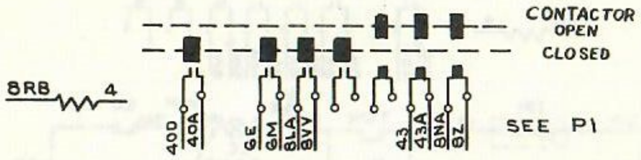
CS "OFF" REPLACES M2 WHEN MULTI-POINT SHUTTER IS FURNISHED

P2 TYPE 17CP2N3 ELECTRO-PNEUMATIC MOTOR PARALLELING CONTACTOR CONTROL COMPARTMENT
CONNECTS MOTOR #1 ACROSS TRACTION GENERATOR


8W
4
41A
41B
HV
18
18H
8N
8V
18B
18D
19J
19B
50
181
13
TDR
8D
BR2
8L
EC
(2-4-6-R)
8LL
CO
1-4
8LA
CO
1-4
P2
8N
CO
2-3
P22
P21
CO
2-3
P1
8VV
S21
8V
8P
S1
GR
8W
8U
P2
P22
136
CC1
100
100
CC2
136
4

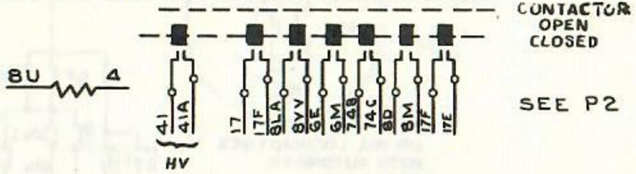
## P21, P22
## R1, R2, R3

P21 TYPE 17CP2N3 ELECTRO-PNEUMATIC MOTOR PARALLELING CONTACTOR
CONTROL COMPARTMENT
CONNECTS MOTOR #2 ACROSS TRACTION GENERATOR


CONTACTOR
OPEN
CLOSED
8RB
4
40D
40A
GE
6M
8LA
8VV
43
43A
8NA
8Z

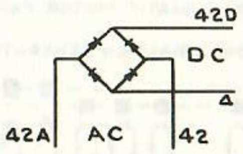
SEE P1

P22 TYPE 17CP2N3 ELECTRO-PNEUMATIC MOTOR PARALLELING CONTACTOR
CONTROL COMPARTMENT
CONNECTS #4 MOTOR ACROSS TRACTION GEN.-


CONTACTOR
OPEN
CLOSED
8U
4
41
41A
HV
17
17F
8LA
8VV
GE
6M
74B
74C
8D
8M
17F
17E

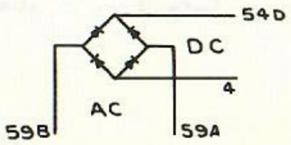
SEE P2

R1 MODEL 6RS5C18 EXCITER FIELD RECTIFIER 17FM7681 PANEL
FURNISHES DC FOR AMPLIDYNE EXCITER FIELD


42D
DC
4
42A
AC
42

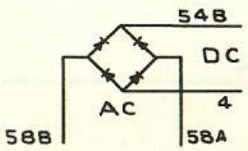
SEE NORMAL AMPLIDYNE EXCITATION FIELD CIRCUITS E2

R2 MODEL 6RS5C18 GENERATOR FIELD RECTIFIER 17FM7681 PANEL
FURNISHES D. C. FOR FIELD LIMIT CONTROL


54D
DC
4
AC
59B
59A

SEE FIELD LIMIT CONTROL EXCITATION CIRCUIT E5

R3 MODEL 6RS5C18 GENERATOR LOAD CONTROL RECTIFIER 17FM7681 PANEL
FURNISHES DC FOR LOAD LIMIT CONTROL

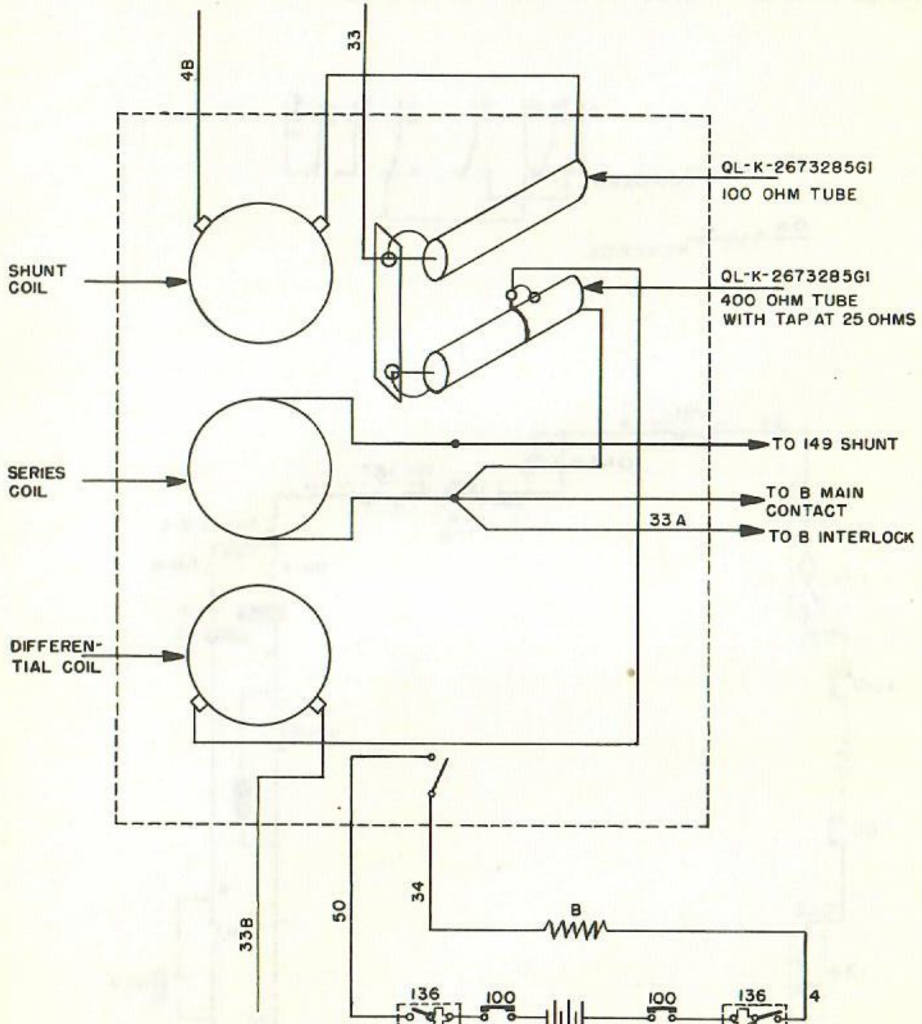

54B
DC
4
AC
58B
58A

SEE CURRENT LIMIT CONTROL EXCITATION E4

---

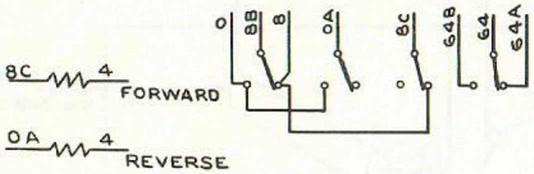
## RC

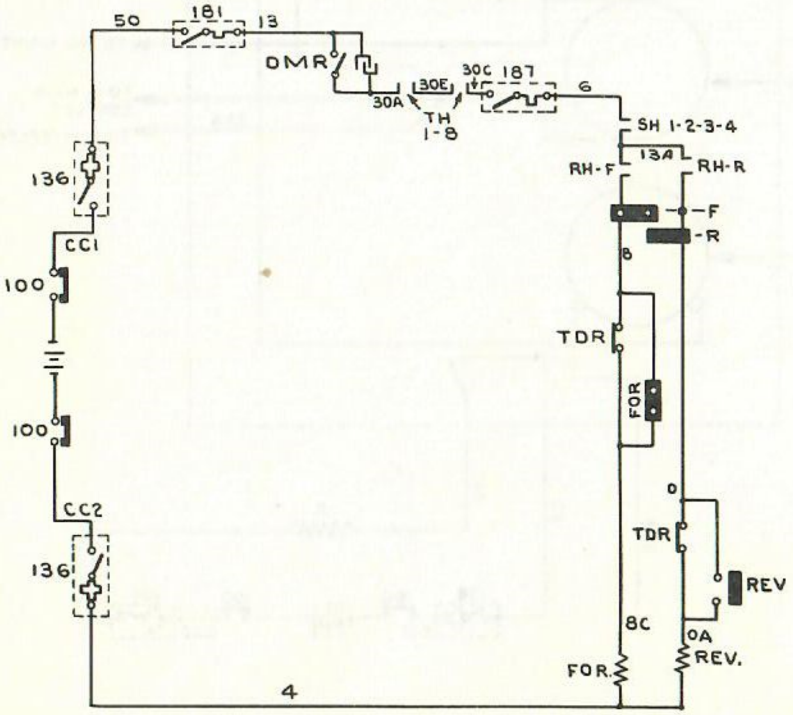
17LC19D14 REVERSE CURRENT RELAY CONTROL COMPARTMENT


4B
33
QL-K-2673285G1
100 OHM TUBE
QL-K-2673285G1
400 OHM TUBE
WITH TAP AT 25 OHMS
SHUNT COIL
SERIES COIL
DIFFEREN-TIAL COIL
TO 149 SHUNT
TO B MAIN CONTACT
33 A
TO B INTERLOCK
33B
50
34
B
136
100
CC1
100
CC2
136
4

## REV
⊣⊢

REV TYPE 17DP13C1 REVERSER FOR MOTOR FIELDS CONTROL COMPARTMENT
REVERSES MOTOR FIELD FOR REVERSING DIRECTION OF LOCOMOTIVE. OPERATED BY TWO MAGNET VALVES - FORWARD AND REVERSE


8C
4
FORWARD
0A
4
REVERSE
0
8B
8
0A
8C
64B
64
64A


50
181
13
DMR
30A
30E
TH
1-8
30C
187
6
SH 1-2-3-4
13A
RH-F
RH-R
-F
-R
8
136
CC1
100
100
CC2
136
TDR
FOR
0
TDR
REV
8C
0A
FOR.
REV.
4

---

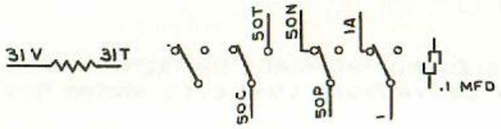
## RH
## SAND
## SAR
## SR
## SH, TH

RH REVERSER HANDLE ON TYPE 17KC66F1 MASTER CONTROLLER
CONTROL STAND
GOVERNS DIRECTION OF LOCOMOTIVE FORWARD OR REVERSE

SEE MASTER CONTROLLER

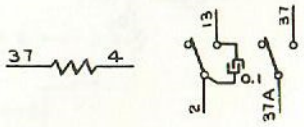
SAND - SEE 188

SAR TYPE 17LV53AB113 SAFETY RELAY 17FM76B1 PANEL
SHUTS DOWN ENGINE IN CASE OF FAILURE IN GOVERNOR TACH. GEN. CIRCUIT


31V
31T
50T
50N
1A
50C
50P
1
.1 MFD

SEE GOVERNOR

SR TYPE 17LV53S115 SIGNAL RELAY 17FM76B1 PANEL
ENERGIZES ALARM GONG CIRCUITS


37
4
13
37
0.1
2
37A

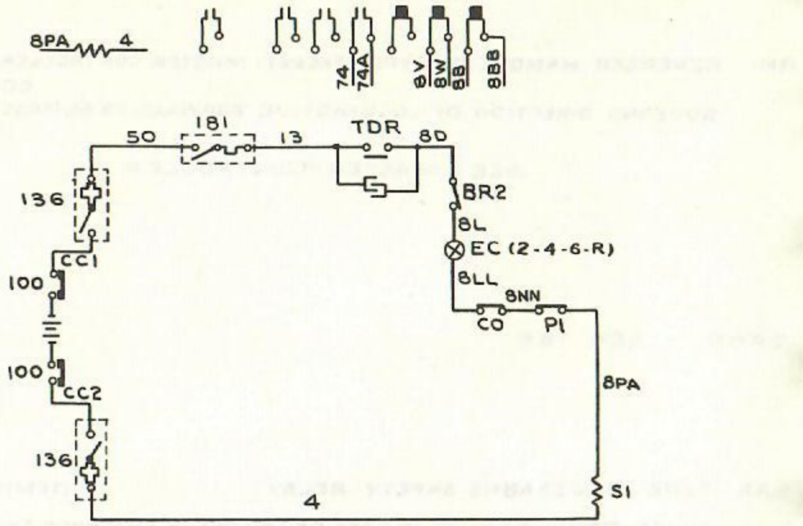
SEE ALARM CIRCUITS

SH SELECTOR HANDLE ON 17KC66F1 MASTER CONTROLLER CONTROL STAND
SELECTS PROPER TRANSITION - SEE MASTER CONTROLLER

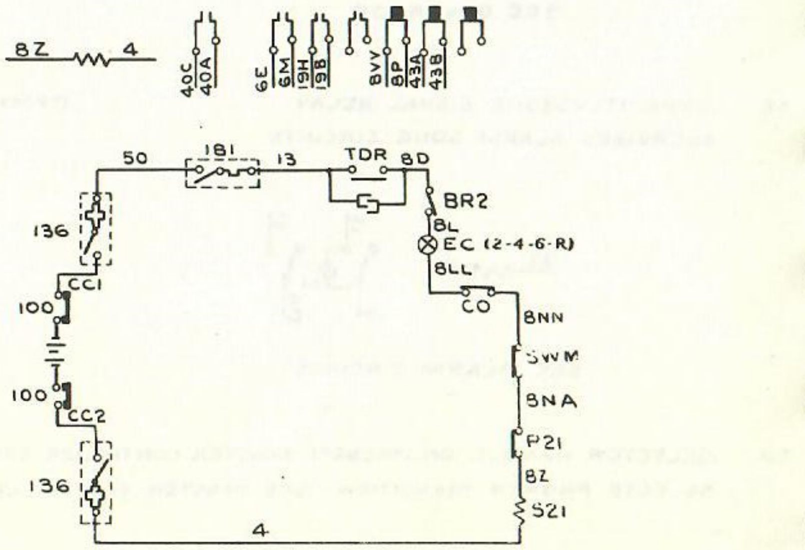
TH THROTTLE HANDLE ON 17KC66F1 MASTER CONTROLLER CONTROL STAND
GOVERNS SPEED OF LOCOMOTIVE - SEE MASTER CONTROLLER

## S1, S21

S1 TYPE 17CP2N3 ELECTRO-PNEUMATIC CONTACTOR COMTROL COMPARTMEN
SERIES POWER CONTACTOR - CONNECTS MOTOR #1 & 3 IN SERIES

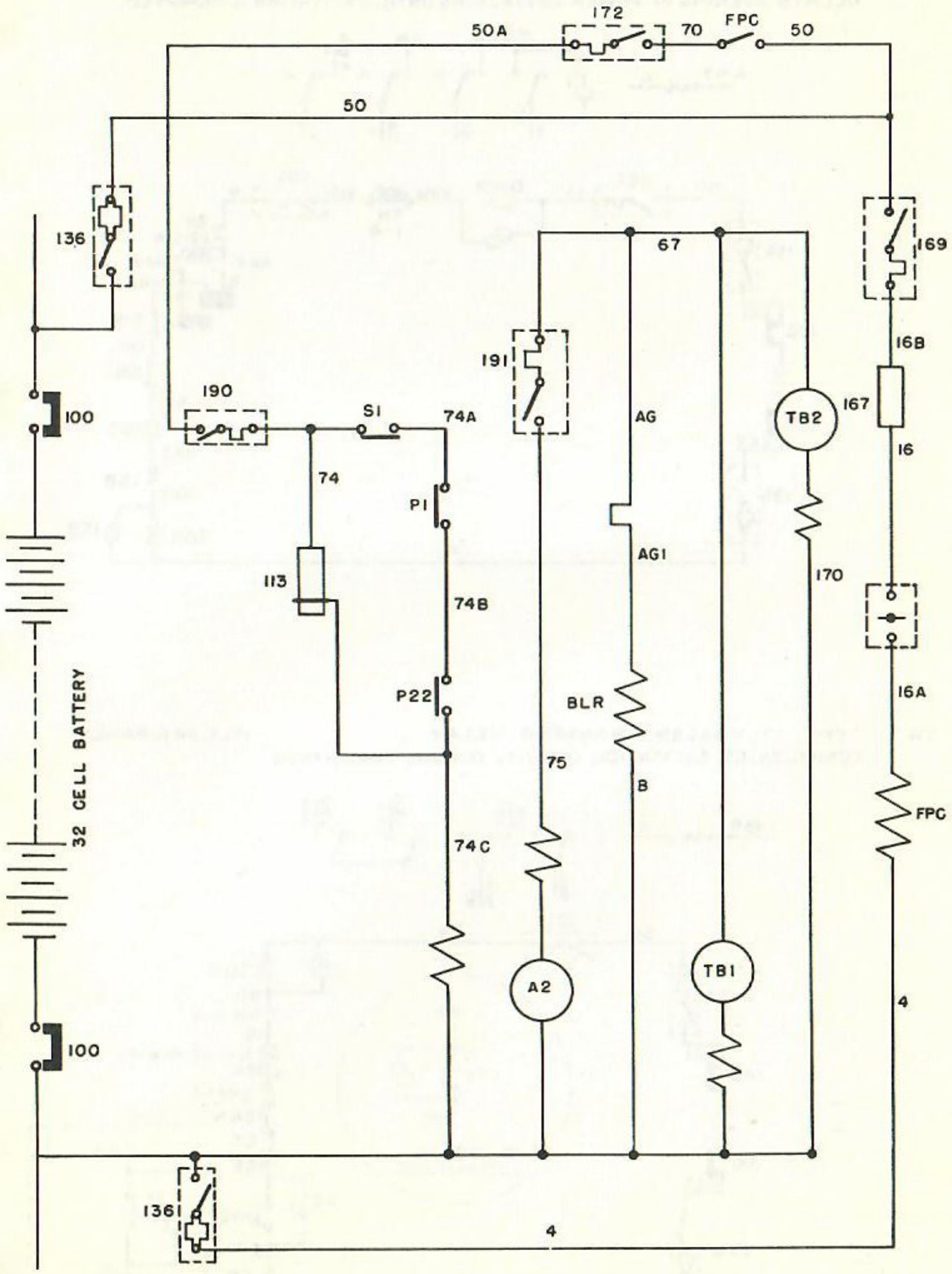

8PA
4
74
74A
8V
8W
8B
8BB
50
181
13
TDR
8D
BR2
8L
EC (2-4-6-R)
8LL
8NN
CO
P1
8PA
136
CC1
100
100
CC2
136
S1
4

S21 TYPE 17CP2N3 ELECTRO-PNEUMATIC CONTACTOR CONTROL COMPARTMENT
SERIES POWER CONTACTOR - CONNECTS MOTOR #2 & 4 IN SERIES


8Z
4
40C
40A
6E
6M
19H
19B
8VV
8P
43A
43B
50
181
13
TDR
8D
BR2
8L
EC (2-4-6-R)
8LL
CO
8NN
SWM
8NA
P21
8Z
S21
136
CC1
100
100
CC2
136
4

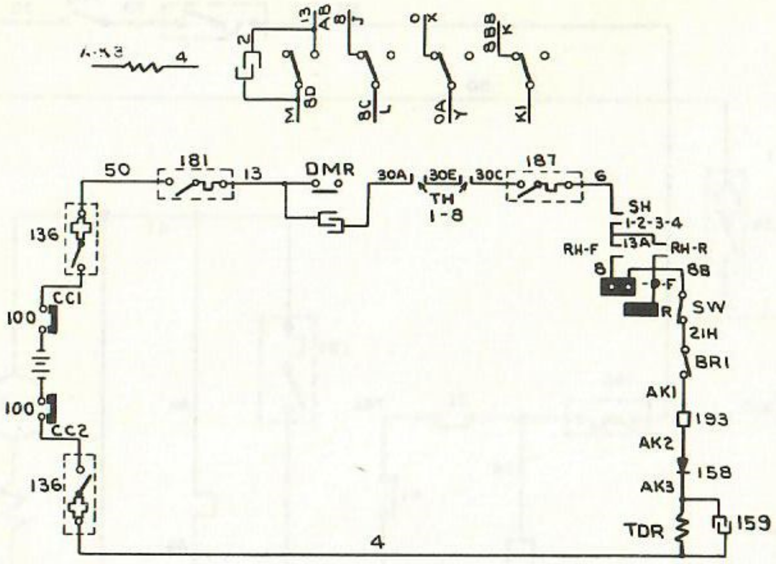
---

## TB1, TB2

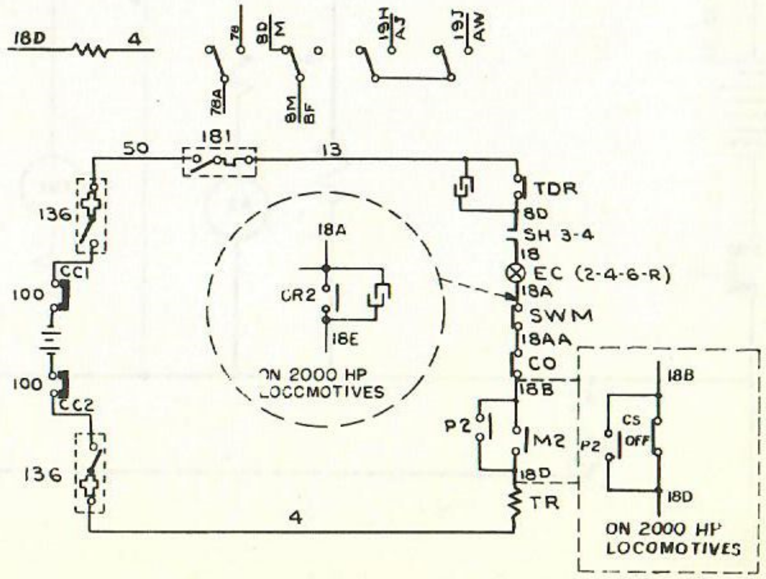

50A
172
70
FPC
50
50
136
169
16B
67
191
167
TB2
16
190
S1
74A
AG
100
74
P1
113
AG1
170
74B
32 CELL BATTERY
P22
BLR
16A
75
B
FPC
74C
A2
TB1
4
100
136
4

## TDR
## TR

TDR TYPE 17LV53C139 TIME DELAY RELAY 17LE34A3 PANEL
DELAYS OPENING OF POWER CONTACTORS UNTIL EXCITATION IS REMOVED


A-K3
4
2
13
AB
8
J
X
8BB
K
M
8D
8C
L
0A
Y
K1
50
181
13
DMR
30A
30E
30C
TH
1-8
187
6
SH
1-2-3-4
13A
RH-F
RH-R
8
8B
F
R
SW
21H
BR1
AK1
193
AK2
158
AK3
TDR
159
136
CC1
100
100
CC2
136
4

TR TYPE 17LV53C39 TRANSFER RELAY 17LE34A PANEL
COMMUTATES EXCITATION CIRCUITS DURING TRANSITION


18D
4
78
78A
8D
M
8M
BF
19H
AJ
19J
AW
50
181
13
TDR
8D
SH 3-4
18
EC (2-4-6-R)
18A
SWM
18AA
CO
18B
P2
M2
18D
TR
4
136
CC1
100
100
CC2
136
18A
CR2
18E
ON 2000 HP
LOCOMOTIVES
18B
CS
OFF
P2
18D
ON 2000 HP
LOCOMOTIVES

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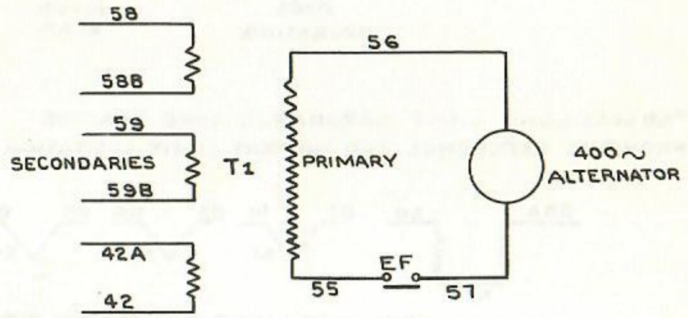
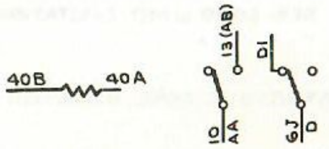
## T1
## WS1, WS2

T1 TYPE 84G256 400 CYCLE EXCITATION TRANSFORMER 17FM7681 PANEL
PRIMARY ENERGIZED BY 400 CYCLE ALTERNATOR, SECONDARY FEEDS
R1-R2 AND R3 RECTIFIERS.

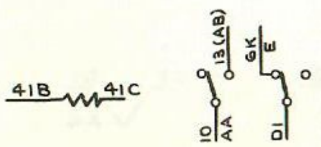

58
58B
59
SECONDARIES
59B
42A
42
T1
PRIMARY
56
400~
ALTERNATOR
EF
55
57

WS1 TYPE 17LV53E19 WHEEL SLIP RELAY 17LE34A PANEL
ENERGIZES BUZZER AND WARNING LIGHT ON WHEEL SLIP ON MOTORS 2 OR 3


40B
40A
13(AB)
D1
10
AA
6J
D

SEE POWER CIRCUITS-MOTOR-GENERATOR &
ALARM CIRCUITS

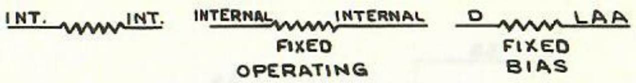
WS2 TYPE 17LV53E19 WHEEL SLIP RELAY 17LE34A PANEL
ENERGIZES BUZZER AND WARNING LIGHT ON WHEEL SLIP ON MOTORS 1 OR 4


41B
41C
13(AB)
6K
E
10
AA
D1

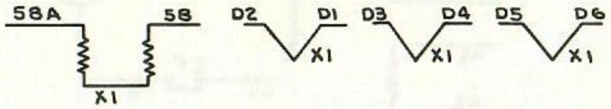
SEE POWER, MOTOR, GENERATOR AND ALARM CIRCUITS

## X, X1, X2
## X3, X4

X TYPE 17LH28 VOLTAGE REGULATOR CONTROL COMPARTMENT
MAINTAINS CONSTANT VOLTAGE OUTPUT OF AUXILIARY GENERATOR THROUGH SPEED RANGE.

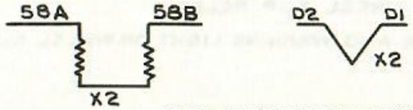

INT.
INT.
INTERNAL
INTERNAL
FIXED
OPERATING
D
LAA
FIXED
BIAS

X1 #69G643 LOAD LIMIT SATURABLE CORE REACTOR 17FM7681 PANEL
PROVIDES REFERENCE FOR CURRENT LIMIT EXCITATION SYSTEM


58A
58
X1
D2
D1
X1
D3
D4
X1
D5
D6
X1

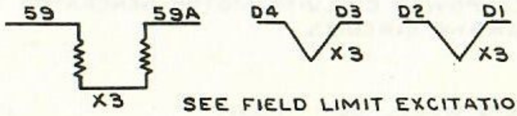
SEE LOAD LIMIT EXCITATION CIRCUIT E4

X2 #69G644 LOAD LIMIT SATURABLE CORE REACTOR 17FM7681 PANEL
OPERATES WITH X.


58A
58B
X2
D2
D1
X2

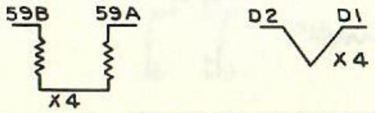
SEE LOAD LIMIT EXCITATION CIRCUIT E4

X3 #69G645 FIELD LIMIT SATURABLE CORE REACTOR 17FM7681 PANEL


59
59A
X3
D4
D3
X3
D2
D1
X3

SEE FIELD LIMIT EXCITATION CIRCUITS E5

X4 #69G644 FIELD LIMIT SATURABLE CORE REACTOR 17FM7681 PANEL
OPERATES WITH X3


59B
59A
X4
D2
D1
X4

SEE FIELD LIMIT EXCITATION CIRCUITS E5

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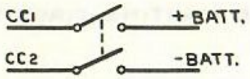
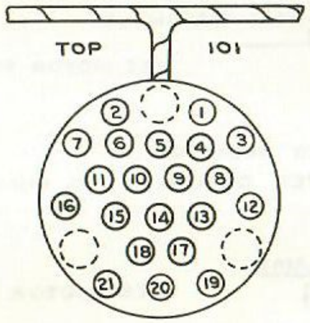
## 100, 101
## 102, 105

100 TYPE 17GH22A1 BATTERY AND T.L. SWITCH ENGINE ROOM
MAIN BATTERY SWITCH - DOUBLE POLE, SINGLE THROW

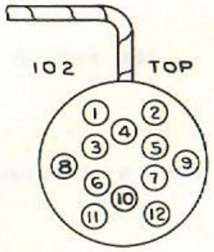

CC1
+BATT.
CC2
-BATT.

SEE BATTERY CHARGING CIRCUIT

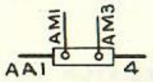
101 TYPE WWRB-421 21 POLE CONTROL RECEPTACLE ENDS OF LOCO.
CONTROL RECEPTACLE FOR TRAIN LINE CONTROL JUMPERS.


TOP
101
2
1
7
6
5
4
3
11
10
9
8
16
15
14
13
12
18
17
21
20
19

102 TYPE DA-90-D1 12 POLE CONTROL RECEPTACLE ENDS OF LOCO.
CONTROL RECEPTACLE FOR TRAIN LINE CONTROL JUMPERS

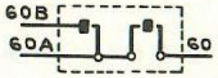

102
TOP
1
2
4
3
5
8
9
6
7
10
11
12

105 FORM 15 AMMETER SHUNT CONTROL COMPARTMENT
SHUNT FOR AMMETER IN MOTOR #1 CIRCUIT


AM1
AM3
AA1
4

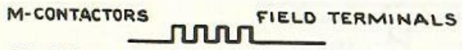
SEE MOTOR POWER CIRCUITS

106 SBI HEADLIGHT SWITCH CONTROL COMPARTMENT
HEADLIGHT SWITCH



SEE LIGHTING CIRCUITS

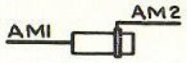
107 TYPE 17EM49D1 2-MOTOR FIELD SHUNTS CONTROL COMPARTMENT
MOTOR FIELD RESISTOR SHUNTS 0.011 OHM



CS ON 2000 HP
LOCOMOTIVES

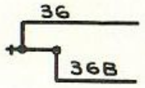
SEE MOTOR POWER CIRCUITS

111 TYPE 0560 AMMETER RESISTOR CONTROL COMPARTMENT
IN MOTOR #1 AMMETER CIRCUIT 5 OHM



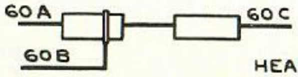
SEE MOTOR POWER CIRCUITS

112 TYPE 17GK43A1 GROUND RELAY CUTOUT SWITCH CONTROL COMPARTMENT
OPENS GROUND COIL CIRCUIT

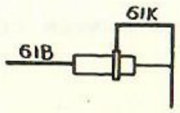


SEE MOTOR POWER CIRCUITS

113 TYPE 17FR24C3 GENERATOR FIELD & HEADLIGHT CIRCUITS
CONTROL COMPARTMENT



HEADLIGHT RESISTORS



GEN. FIELD RESISTOR

SEE LIGHTING CIRCUITS

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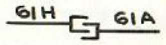
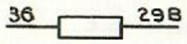
114 #94708 ANTI-HUNT EXCITER FIELD CAPACITOR 17LE34A3 PANEL
IN F8-F7 FIELD OF EXCITER



SEE E1

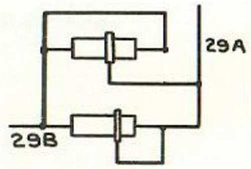
116 TYPE 17FR26A1 CR FIELD TEMP. COMPENSATING RESISTOR CONTROL COMPARTMENT
COMPENSATING RESISTORS FOR C.P. FIELD
TEMPERATURE RISE. 0.538 OHMS



SEE CURRENT LIMIT CONTROL
EXCITATION CIRCUITS E4

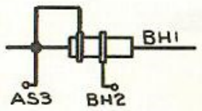
116A #0560A CONTROL RESISTOR 17FM64B1 PANEL

0.123 OHM



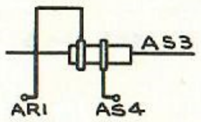
SEE CURRENT LIMIT CONTROL
EXCITATION CIRCUITS E4

117 #0567 CURRENT LIMIT ADJUSTMENT 17LE34A3 PANEL
CURRENT LIMIT AND FUEL LIMIT RESISTORS CONTROLLED BY
SEQUENCE RELAYS



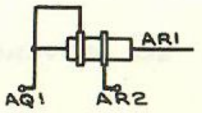
200 OHMS ADJUST TO 78 OHMS
BETWEEN BH2-BH1
BH2-AS3
SEE E4

118 #0568C CURRENT LIMIT ADJUSTMENT 17LE34A3 PANEL
CURRENT LIMIT AND FUEL LIMIT RESISTOR CONTROLLED BY
SEQUENCE RELAY



400 OHMS ADJUSTED TO 114 OHMS
BETWEEN AS4-AS3 AND
177 OHMS BETWEEN AR1-AS4
SEE E4

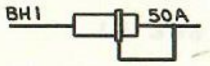
118A #0574 CURRENT LIMIT ADJUSTMENT 17LE34A3 PANEL
CURRENT LIMIT AND FUEL LIMIT RESISTOR CONTROLLED BY
SEQUENCE RELAY.



2000 OHMS ADJUST TO 329 OHMS
BETWEEN AR2-AR1 AND
1485 OHMS BETWEEN AQ1-AR2
SEE E4

## 119, 120, 121
## 122, 122A, 124

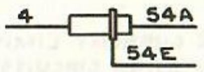
119 #0569 8TH NOTCH ADJUSTING RESISTOR 17LE34A3 PANEL
8TH NOTCH ADJUSTMENT SAME AS 117-118-118A



500 OHM ADJUSTED TO 300 OHMS

SEE E4

120 #0562 EXCITATION CIRCUIT RESISTOR 17FM64B1 PANEL

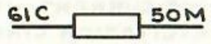


25 OHM 54E-4 - 12.5 OHMS
54A-54E- 7.5 OHMS

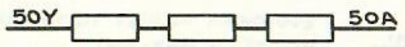
SEE E2

121 #0411 STABILIZING SHUT OFF RESISTOR 17FM76B1 PANEL
IN ANTICIPATION CIRCUIT OF GOVERNOR 5000 OHMS

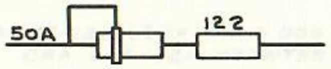
SEE GOVERNOR



122 #0400K ALTERNATOR FIELD RESISTOR 17FM64B1 PANEL
IN 400 CYCLE ALTERNATOR FIELD 3-4 OHM RESISTORS

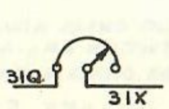


122A #0560C ALTERNATOR FIELD RESISTOR 17FM64B1 PANEL
IN 400 CYCLE ALTERNATOR FIELD 4 OHMS



SEE MG

124 #0156 FUEL LIMIT 7TH & 8TH NOTCH ADJUSTMENT 17FM76B1 PANEL
8TH NOTCH FUEL LIMIT TRIMMER RESISTOR 500 Ω



SEE GOVERNOR

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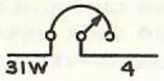
## 124A, 125, 125A
## 126, 126A, 126B

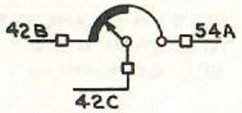
124A #0158 FUEL LIMIT 3RD & 4TH NOTCH ADJUSTMENT 17FM76B1 PANEL

1000 OHM

SEE GOVERNOR

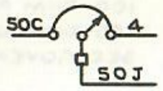


125 GOVERNOR LOAD CONTROL RHEOSTAT ON GOVERNOR
OPERATED BY GOVERNOR TO REDUCE EXCITATION TO
MAINTAIN SPEED



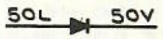
17 OHM
SEE E2

125A GOVERNOR STABILIZING RHEOSTAT ON GOVERNOR
OPERATED BY GOVERNOR FOR STABILIZING ACTION OF SPEED COIL



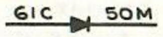
118.5 OHM
SEE GOVERNOR

126 4H3C1 GOVERNOR STABILIZING RECTIFIER 17FM76B1 PANEL
PREVENTS BACK FEED TO STABILIZING COIL



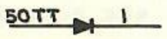
SEE GOVERNOR

126A 6RS5FB11 GOVERNOR STABILIZING RECTIFIER 17FM76B1 PANEL
SAME AS 126



SEE GOVERNOR

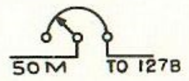
126B 6RS5FB11 BACK CIRCUIT RECTIFIER 17FM76B1 PANEL
PREVENTS BACK FEED IN CLUTCH COIL CIRCUIT



SEE GOVERNOR

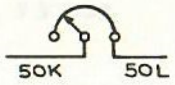
## 127, 127A, 127B
## 128, 128A, 129

127 #0151 STABILIZING RESISTOR GOVERNOR CIRCUIT 17FM76B1



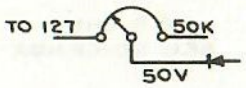
100 OHM RHEOSTAT
50 OHM USED
SEE GOVERNOR

127A #0159 STABILIZING RESISTOR GOVERNOR CIRCUIT 17FM76B1
IN GOVERNOR STABILIZING COIL CIRCUIT



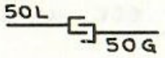
1500 OHM RHEOSTAT
1000 OHM USED
SEE GOVERNOR

127B #0151 STABILIZING RESISTOR GOVERNOR CIRCUIT 17FM76B1
IN GOVERNOR STABILIZING COIL CIRCUIT



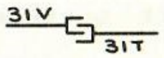
100 OHM RHEOSTAT
50 OHM USED
SEE GOVERNOR

128 CAT. 94757 GOVERNOR STABILIZING CAPACITORS 17FM76B1 PANEL
CAPACITOR FOR STABILIZING COIL CIRCUIT



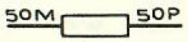
6 - 500 MFD
SEE GOVERNOR

128A CAT. 94757 SAR CAPACITOR 17FM76B1 PANEL
ACROSS SAR COIL



1 - 500 MFD
SEE GOVERNOR

129 #0400F STABILIZING COIL FORCE OFF 17FM76B1 PANEL
IN STABILIZING COIL CIRCUIT ACROSS BATTERY



100 OHM USED
SEE GOVERNOR

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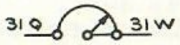
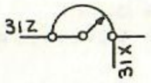
## 130, 131, 132
## 132A, 132B, 132C

130 #0150 FUEL LIMIT (CO) 17FM76B1 PANEL
IN FUEL LIMIT CIRCUIT SHORTED BY CO.



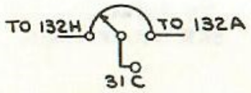
75 OHM
SEE GOVERNOR

131 GOVERNOR FUEL LIMIT RHEOSTAT ON GOVERNOR
OPERATED BY FUEL LIMIT CAM TRAVEL. REPLACES RESISTANCE IN CIRCUIT REMOVED BY NOTCHING RESISTORS.



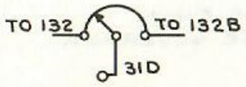
175 OHM
SEE GOVERNOR

132 #0148 IDLE SPEED ADJUSTING RESISTOR 17FM76B1 PANEL
TO ADJUST ENGINE IDLE SPEED



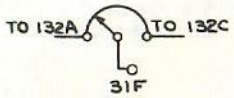
35 OHM
SEE GOVERNOR

132A #0148 2ND NOTCH SPEED ADJUSTING RESISTOR 17FM76B1 PANEL
TO ADJUST ENGINE SPEED AT 2ND NOTCH



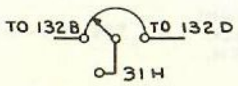
35 OHM
SEE GOVERNOR

132B #0148 3RD NOTCH SPEED ADJUSTING RESISTOR 17FM76B1 PANEL
TO ADJUST ENGINE SPEED AT 3RD NOTCH



35 OHM
SEE GOVERNOR

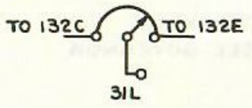
132C #0148 4TH NOTCH SPEED ADJUSTING RESISTOR 17FM76B1 PANEL
TO ADJUST ENGINE SPEED AT 4TH NOTCH



35 OHM
SEE GOVERNOR

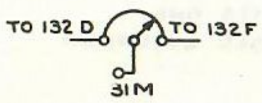
## 132D, 132E, 132F
## 132G, 132H, 133

132D #0147 5TH NOTCH SPEED ADJUSTING RESISTOR 17FM76B1 PANEL
TO ADJUST ENGINE SPEED 5TH NOTCH


TO 132C
TO 132E
31L

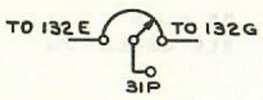
25 OHM
SEE GOVERNOR

132E #0147 6TH NOTCH SPEED ADJUSTING RESISTOR 17FM76B1 PANEL
TO ADJUST ENGINE SPEED 6TH NOTCH


TO 132 D
TO 132F
31M

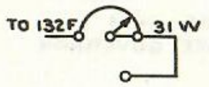
25 OHM
SEE GOVERNOR

132F #0147 7TH NOTCH SPEED ADJUSTING RESISTOR 17FM76B1 PANEL
TO ADJUST ENGINE SPEED 7TH NOTCH


TO 132 E
TO 132G
31P

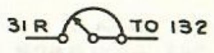
25 OHM
SEE GOVERNOR

132G #0148 8TH NOTCH SPEED ADJUSTING RESISTOR 17FM76B1 PANEL
TO ADJUST ENGINE SPEED 8TH NOTCH



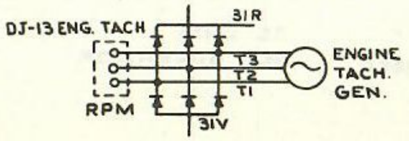
35 OHM
SEE GOVERNOR

132H #0149 OVERSPEED CHECK 17FM76B1 PANEL
TO CHECK OVERSPEED ON ENGINE



50 OHM
34 OHM USED

133 6RS120C1 TACHOMETER GENERATOR RECTIFIER 17FM76B1 PANEL
RECTIFIES AC TO DC OF TACHOMETER GENERATOR FOR SPEED COIL OPERATION - THREE RECTIFIERS


DJ-13 ENG. TACH
RPM
31R
31V
T3
T2
T1
ENGINE
TACH.
GEN.

SEE GOVERNOR

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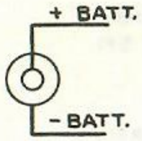
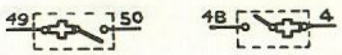
## 134, 136, 137
## 142, 142A, 142B

134 BCRFB-5150 BATTERY CHARGING RECEPTACLE LOCOMOTIVE SIDE
PERMITS CONNECTION FOR EXTERNAL SOURCE BATTERY CHARGING



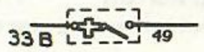
SEE BATTERY CHARGING CIRCUIT

136 K60A-150 MAIN CONTROL CIRCUIT BREAKER CONTROL COMPARTMENT
2-BREAKERS FOR MAIN POWER CONTROL 150 AMP



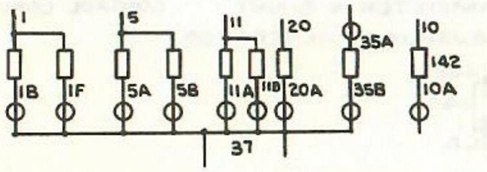
SEE BATTERY CHARGING CIRCUIT

137 K60A-200 AUXILIARY GENERATOR CIRCUIT BREAKER CONTROL COMPARTMENT
PROTECTS CIRCUIT OF BATTERY TO AUX. GENERATOR 200 AMP



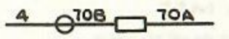
SEE BATTERY CHARGING CIRCUIT

142 #0371B SIGNAL LAMP 17FM76B1 PANEL
8 - IN SERIES WITH SIGNAL LAMPS EACH 300 Ω

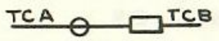

1
5
11
20
35A
10
142
1B
1F
5A
5B
11A
11B
20A
35B
10A
37

SEE SR

142A EXHAUSTER SIGNAL LAMP #0568B 17FM76B1 PANEL
1-IN SERIES WITH SIGNAL LAMP 300 Ω

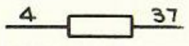


142B #0200F TRAIN CONTROL CHECK LIGHT CONTROL STAND
IN SERIES WITH CHECK LAMP 100 Ω



## 143, 145, 147, 148
## 149, 151, 152

143 #0400C SR RELAY CIRCUIT 17FM76B1 PANEL
IN PARALLEL WITH SR WHEN SR CLOSES

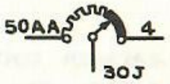


25 OHM
SEE SR

145 17LM30B1 RADIATOR FAN CONTROL RELAY 17FM76B1 PANEL
FOR CONTROLLING RADIATOR FAN SPEED

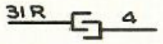
SEE AUXILIARIES

147 BRAKE POTENTIOMETER CONTROL STAND



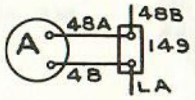
58.17 OHM
SEE MASTER CONTROLLER

148 CAT. 94757 GOVERNOR STABILIZING CAPACITOR 17FM76B1 PANEL
STABILIZING CAPACITORS SHORT OUT NOTCHING RESISTORS
6-500 MFD

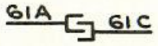


SEE GOVERNOR

149 DO-47 GENERATOR AMMETER & SHUNT CONTROL COMPARTMENT
MEASURES LOAD OF AUXILIARY GENERATOR

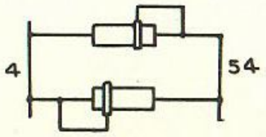


151 CAT. 94757 STABILIZER SHUT-OFF CAPACITOR
IN STABILIZING COIL CIRCUIT ENERGIZED BY EXCITER



500 MFD
SEE GOVERNOR

152 #0562 EXC. FOR FLD. 17FM64B1 PANEL
2-25 OHM



SEE E2

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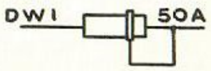
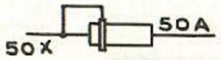
## 153, 154, 155
## 156, 157, 157A

153 #0572 1st NOTCH ADJUSTING RESISTOR 17LE34A3
FOR 1st NOTCH ADJ. FOR CURRENT LIMIT CONTROL EXCITATION CIRCUITS



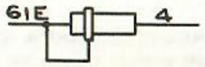
1000 OHM
ADJ. TO 630 Ω SEE E4

154 #0573 GENERATOR FIELD LIMITER ADJUSTING RESISTOR 17FM64B1
FOR ADJUSTING FIELD LIMIT CONTROL EXCITATION CIRCUIT



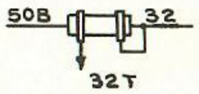
1500 OHM
ADJ. TO 850 Ω SEE E5

155 #0200B SUICIDE CIRCUIT CURRENT LIMIT RESISTOR 17FM64B1
FOR ADJUSTING F4-F3 FIELD OF EXCITER



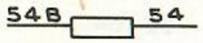
100 OHM
SEE E1

156 #0572 GENERATOR LOAD CURRENT LIMIT ADJUSTMENT RESISTOR
FOR ADJUSTING CURRENT LIMIT CONTROL EXCITATION CIRCUIT 17FM64B1



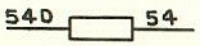
1000 OHM
ADJ. FOR 500 Ω SEE E4

157 #0560C BRAKING CONTROL SENSITIVITY RESISTOR 17FM64B1
FOR ADJUSTING BRAKING CONTROL



3 OHM SHORTED OUT WITH
NO BRAKING CONTROL
FURNISHED
SEE E5

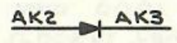
157A #0200L CURRENT LIMIT SENSITIVITY ADJUSTING RESISTOR 17FM64B1
FOR ADJUSTING FIELD LIMIT CONTROL CIRCUIT SENSITIVITY



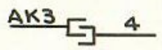
3 OHM SEE E5

## 158, 159, 161, 162
## 164, 165, 165A

158 6RS16A1 TDR RECTIFIER 17LE34A3 PANEL
TO PREVENT FEED BACK FROM DISCHARGE AT 159

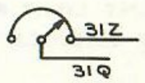


159 CAT. 94757 TDR CAPACITOR 17LE34A3 PANEL
ACROSS TDR COIL TO DELAY OPENING



500 MFD
SEE TDR

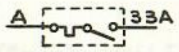
161 #0149 FUEL LIMIT ADJUSTING RESISTOR 17FM76B1
OVERALL FUEL LIMIT ADJUSTMENT- USUALLY SET IN 5TH NOTCH



50 OHM
ADJ. TO 35 OHM

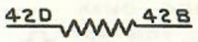
SEE GOVERNOR

162 K80-15 AUX. GENERATOR FLD. CIRCUIT BREAKER CONTROL COMPARTMENT
FOR PROTECTION TO AUX. GENERATOR FIELD CIRCUITS AND REGULATOR

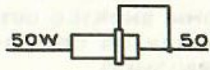


SEE BATTERY
CHARGING CIRCUITS

164 69G576 FILTER REACTOR

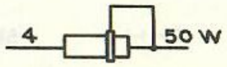


165 #0570 MOTOR FLD. CURRENT ADJUSTING RESISTOR FOR BRAKING
17 FM64B1



750 OHM

165A #0572 MOTOR FLD. CURRENT ADJUSTING RESISTOR FOR BRAKING
FIELD ADJUSTMENT, CONTROL CIRCUIT FOR BRAKING 17 FM64B1



1000 OHM

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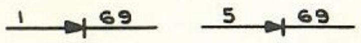
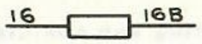
## 166, 167, 168, 169
## 170, 171, 172

166 6RS112CB1 POWER OFF LIGHT RECTIFIERS

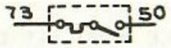


167 #0400B TRAIN LINE RESISTOR CONTROL STAND
RESISTOR IN TRAIN LINE FOR FUEL PUMP CONTACTOR COIL



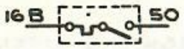
10 OHM
SEE AUXILIARIES CIRCUIT

168 K80-15 TRAIN CONTROL BREAKER CONTROL STAND
PROTECTS TRAIN CONTROL CIRCUITS

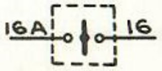


SEE AUXILIARIES CIRCUIT

169 K80-15 MASTER FUEL PUMP BREAKER CONTROL STAND
PROTECTS FUEL PUMP CONTACTOR CIRCUITS

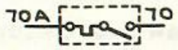


170 2228S ENGINE AUXILIARY SWITCH 17FM76B1 PANEL
CONTROLS FPC



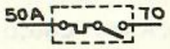
SEE AUXILIARY CIRCUITS

171 K80-15 CRANKSHAFT EXHAUSTER BREAKER CONTROL COMPARTMENT
PROTECTS CRANKCASE EXHAUSTER MOTOR CIRCUIT



SEE AUXILIARIES CIRCUIT

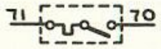
172 K60A-70 M.G. SET BREAKER CONTROL COMPARTMENT
PROTECTS MOTOR CIRCUIT OF 400 CYCLE M.G. SET



SEE AUXILIARIES CIRCUIT

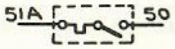
## 173, 176, 177, 178
## 179, 180, 181

173 K80-35 FUEL PUMP BREAKER CONTROL COMPARTMENT
PROTECTS MOTOR DRIVING FUEL PUMP AND RADIATOR FAN CONTROL



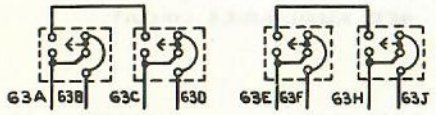
SEE AUXILIARIES CIRCUIT

176 K80-15 CAB LIGHTS AND AUX. BREAKER CONTROL COMPARTMENT
PROTECTS CAB LIGHTS AND AUXILIARIES CIRCUITS



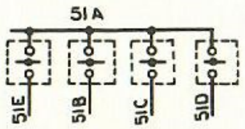
SEE LIGHTING AND AUXILIARIES CIRCUITS

177 CAT. 15502 HEATER AND DEFROSTER RHEOSTATS CONTROL STAND
RHEOSTATS FOR CONTROLLING HEATERS AND DEFROSTERS



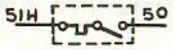
SEE AUXILIARIES CIRCUIT

178 2228S LIGHT SWITCHES CONTROL STAND



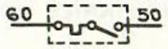
SEE LIGHTING CIRCUITS

179 K80-35 ENGINE ROOM LIGHT BREAKERS CONTROL COMPARTMENT
PROTECTS ENGINE ROOM LIGHTING



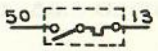
SEE LIGHTING CIRCUITS

180 K80-15 HEAD LIGHT BREAKER CONTROL COMPARTMENT
PROTECTS HEAD LIGHT CIRCUIT



SEE LIGHTING CIRCUITS

181 K80-15 CONTROL BREAKER CONTROL STAND
PROTECTS CONTROL CIRCUITS



SEE ALARM CIRCUITS

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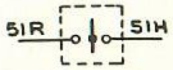
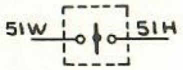
## 182, 183, 184
## 185, 187, 188

182 CAT. 7371 COMPARTMENT LIGHT SWITCH CONTROL COMPARTMENT
OPERATES COMPARTMENT LIGHTS



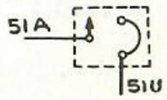
SEE LIGHTING CIRCUIT

183 2228S ENGINE PANEL LIGHT SWITCH 17FM76B1 PANEL
OPERATES ENGINE PANEL LIGHT



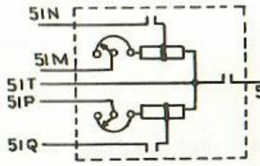
SEE LIGHTING CIRCUITS

184 #0320 FIREMAN'S COWL LIGHT RHEOSTAT FIREMAN'S PANEL
FIREMAN'S COWL LIGHT RHEOSTAT



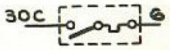
SEE LIGHTING CIRCUITS

185 17FM67A2 GUAGE LIGHT RHEOSTAT PANEL CONTROL STAND
CONTROLS BLACK LIGHTING SYSTEM OF GAUGE PANEL



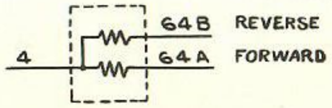
SEE LIGHTING CIRCUITS

187 K80-15 GENERATOR FIELD BREAKER CONTROL STAND
PROTECTS CONTROL CIRCUIT FOR GENERATOR FIELD



SEE EF

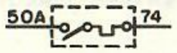
188 17ME2A6 SANDER VALVES ENGINE ROOM
CONTROLS AIR PRESSURE FOR SANDING



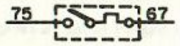
SEE ALARM CIRCUITS

## 190, 191, 192, 193
## 195, 196, 197

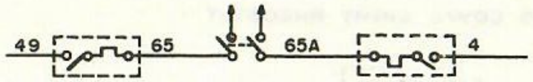
190 K-80-15 BLOWER GENERATOR FIELD CONTROL COMPARTMENT



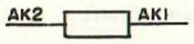
191 K-60A-200 BLOWER GENERATOR BREAKER CONTROL COMPARTMENT



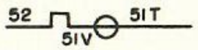
192 K-60A-100 BOILER BREAKER CONTROL COMPARTMENT SEE SECTION I



193 0400F 100 OHM TUBE RESISTOR 17LE34A3 PANEL

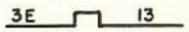


195 0564 INDICATOR LIGHT RESISTOR CONTROL STAND
RESISTOR IN SERIES WITH INDICATOR LAMP



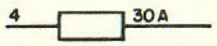
10 OHM SEE LIGHTING CIRCUITS

196 0400B TRAIN LINE RESISTOR CONTROL STAND
IN SERIES WITH ESR



10 OHM

197 0206 DISCHARGE RESISTOR CONTROL STAND



1500 OHM

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## SEQUENCE TABLE

| OPERATION | MOTOR CONNECTION | SELECTOR SHANDLE POSITION | THROTTLE HANDLE NOTCH | EC-ENG. CONTROL SW. | CONTACTORS AND RELAYS |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  | S1 | P1-P21 | P2 | S21 | P22 | TDR | M1 | M2, M3, M4 | TR | GS1, GS2 | GF | FPC | EF | DMR | AVE, AVS | BVS | CVF, CVS | DVS |  | OPR | ESR |  |
| SHUT DOWN | CONTROL SW. OPEN | OFF | IDLE | O |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ENG. START | CONTROL SW CLOSED | OFF | IDLE | S |  |  |  |  |  |  |  |  |  |  | ● |  | ● |  |  |  |  |  |  |  |  |  |  |
| IDLING | CONTROL SW CLOSED | OFF | IDLE | I |  |  |  |  |  |  |  |  |  |  |  |  | ● |  | ● |  |  |  |  |  | ● |  |  |
| MOTORING | SERIES | 1 | 1 | R |  | ● |  |  | ● |  | ● |  |  |  |  | ● | ● | ● | ● |  |  |  |  |  | ● |  |  |
|  |  |  | 2 | R |  | ● |  |  | ● |  | ● |  |  |  |  | ● | ● | ● | ● | ● |  |  |  |  | ● |  |  |
|  |  |  | 3 | R |  | ● |  |  | ● |  | ● |  |  |  |  | ● | ● | ● | ● |  |  | ● |  |  | ● |  |  |
|  |  |  | 4 | R |  | ● |  |  | ● |  | ● |  |  |  |  | ● | ● | ● | ● | ● |  | ● |  |  | ● |  |  |
|  |  |  | 5 | R |  | ● |  |  | ● |  | ● |  |  |  |  | ● | ● | ● | ● |  | ● | ● | ● |  | ● |  |  |
|  |  |  | 6 | R |  | ● |  |  | ● |  | ● |  |  |  |  | ● | ● | ● | ● | ● | ● | ● | ● |  | ● |  |  |
|  |  |  | 7 | R |  | ● |  |  | ● |  | ● |  |  |  |  | ● | ● | ● | ● |  | ● | ● |  |  | ● |  |  |
|  |  |  | 8 | R |  | ● |  |  | ● |  | ● |  |  |  |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  | SERIES FS2 | 2 | 8 | R |  | ● |  |  | ● |  | ● | ● |  |  |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  |  |  |  | R |  | ● |  |  | ● |  | ● | ● | ● |  |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  |  | 2 | 8 | R |  | ● |  |  | ● |  | ● | ● | ● |  |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  | FORWARD TRANSITION (2 TO 3) | 3 | 8 | R |  | ● |  |  | ● |  | ● |  | ● |  |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  |  |  |  | R |  | ● |  |  | ● |  | ● |  |  | ● |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  |  |  |  | R |  | ● |  |  | ● |  | ● |  |  | ● |  |  | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  |  |  |  | R |  | ● | ● |  | ● |  | ● |  |  | ● |  |  | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  |  |  |  | R |  |  | ● | ● |  | ● | ● |  |  | ● |  |  | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  | PARALLEL | 3 | 8 | R |  |  | ● | ● |  | ● | ● |  |  | ● |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | PARALLEL FS2 | 4 | 8 | R |  |  | ● | ● |  | ● | ● | ● |  | ● |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  |  |  |  | R |  |  | ● | ● |  | ● | ● | ● | ● | ● |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  |  | 3 | 8 | R |  |  | ● | ● |  | ● | ● |  |  | ● |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  | BACKWARD TRANSITION (3 TO 2) | 2 | 8 | R |  |  |  | ● |  | ● | ● |  |  |  |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  |  |  |  | R |  | ● |  | ● | ● | ● | ● |  |  |  |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  |  |  |  | R |  | ● |  |  | ● |  | ● |  |  |  |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  |  |  |  | R |  | ● |  |  | ● |  | ● | ● |  |  |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  | SERIES FS2 | 2 | 8 | R |  | ● |  |  | ● |  | ● | ● | ● |  |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| IDLING |  | 1 TO 4 | IDLE | R |  |  |  |  |  |  |  |  |  |  |  |  | ● |  | ● |  |  |  |  |  | ● |  |  |
| CUTOUT MOTORING | #1 & #4 MOTORS CUTOUT | 1 | 1 | R |  |  | ● |  |  |  | ● |  |  | ● |  | ● | ● | ● | ● |  |  |  |  |  | ● |  |  |
|  |  |  | 8 | R |  |  | ● |  |  |  | ● |  |  | ● |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  |  | 2 | 8 | R |  |  | ● |  |  |  | ● | ● | ● | ● |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  |  | 3 | 8 | R |  |  | ● |  |  |  | ● |  |  | ● |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  |  | 4 | 8 | R |  |  | ● |  |  |  | ● | ● | ● | ● |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  | #2 & #3 MOTORS CUTOUT | 1 | 1 | R |  |  |  | ● |  | ● | ● |  |  | ● |  | ● | ● | ● | ● |  |  |  |  |  | ● |  |  |
|  |  |  | 8 | R |  |  |  | ● |  | ● | ● |  |  | ● |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  |  | 2 | 8 | R |  |  |  | ● |  | ● | ● | ● | ● | ● |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  |  | 3 | 8 | R |  |  |  | ● |  | ● | ● |  |  | ● |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  |  | 4 | 8 | R |  |  |  | ● |  | ● | ● | ● | ● | ● |  | ● | ● | ● | ● | ● | ● | ● |  |  | ● |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| M.U. ENG STOP | ANY | ANY | ANY | R OR I | DEPEND ON HANDLE POSITIONS |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ● |  |  | ● |  |
| ENG. STOP BY EC SWITCH | ANY | ANY | ANY | O |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

1500-HP ROAD SWITCHER

## SEQUENCE TABLE

| OPERATION | MOTOR CONNECTION | SH SELECTOR HANDLE POSITION | TH THROTTLE HANDLE NOTCH | CONTACTORS | | | | | | | | | | | | RELAYS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | S1 | P1-P21 | P2 | S21 | P22 | TDR | M1 | M2,M3,M4 | TR | GS1,GS2 | FPC | EF | DMR | AVF,AVS | BVS | CVF,CVS | DVS | BR1,BR2 | GF | OPR | ESR |
| SHUT DOWN | CONT. SW. OPEN | OFF | IDLE | | | | | | | | | | | | | | | | | | | | | |
| ENG. START | CONT. SW. CLOSED | OFF | IDLE | | | | | | | | | | ● | ● | | | | | | | | | | |
| IDLING | CONT. SW. CLOSED | OFF | IDLE | | | | | | | | | | | ● | | ● | | | | | | | ● | |
| MOTORING | SERIES | 1 | 1 | ● | | | ● | | ● | | | | | ● | ● | ● | | | | | | ● | ● | |
| | | | 2 | ● | | | ● | | ● | | | | | ● | ● | ● | ● | | | | | ● | ● | |
| | | | 3 | ● | | | ● | | ● | | | | | ● | ● | ● | | | ● | | | ● | ● | |
| | | | 4 | ● | | | ● | | ● | | | | | ● | ● | ● | ● | | ● | | | ● | ● | |
| | | | 5 | ● | | | ● | | ● | | | | | ● | ● | ● | | ● | ● | ● | | ● | ● | |
| | | | 6 | ● | | | ● | | ● | | | | | ● | ● | ● | ● | ● | ● | ● | | ● | ● | |
| | | | 7 | ● | | | ● | | ● | | | | | ● | ● | ● | | ● | ● | | | ● | ● | |
| | | | 8 | ● | | | ● | | ● | | | | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | SERIES FS2 | 2 | 8 | ● | | | ● | | ● | ● | | | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | | | ● | | | ● | | ● | ● | ● | | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | FORWARD TRANSITION (2 TO 3) | 3 | 8 | ● | | | ● | | ● | ● | ● | | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | | | ● | | | ● | | ● | | | | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | | | ● | | | ● | | ● | | | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | | | ● | | | ● | | ● | | | ● | | ● | ● | ● | ● | ● | ● | | | | ● | |
| | | | | ● | ● | | ● | | ● | | | ● | | ● | ● | ● | ● | ● | ● | | | | ● | |
| | | | | | ● | | | | ● | | | ● | | ● | | ● | ● | ● | ● | | | | ● | |
| | | | | | ● | ● | | ● | ● | | | ● | | ● | | ● | ● | ● | ● | | | | ● | |
| | PARALLEL | 3 | 8 | | ● | ● | | ● | ● | | | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | | 7 | | ● | ● | | ● | ● | | | ● | | ● | ● | ● | | ● | ● | | | ● | ● | |
| | | | 8 | | ● | ● | | ● | ● | | | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | PARALLEL FS2 | 4 | 8 | | ● | ● | | ● | ● | ● | | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | | | | ● | ● | | ● | ● | ● | ● | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | BACKWARD TRANSITION (3 TO 2) | 2 | 8 | | ● | ● | | ● | ● | | | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | | | | | ● | | ● | ● | | | | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | | | ● | | ● | ● | ● | ● | | | | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | | | ● | | | ● | | ● | | | | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | | | ● | | | ● | | ● | ● | | | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | SERIES FS2 | 2 | 8 | ● | | | ● | | ● | ● | ● | | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | SERIES FS1 | 1 | 8 | ● | | | ● | | ● | | | | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| IDLING | | 1 TO 4 | IDLE | | | | | | | | | | | ● | | ● | | | | | | | ● | |
| CUTOUT MOTORING | #1 & #4 MOTORS CUTOUT | 1 | 1 | | ● | | | | ● | | | ● | | ● | ● | ● | | | | | | ● | ● | |
| | | | 8 | | ● | | | | ● | | | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | 2 | 8 | | ● | | | | ● | ● | ● | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | 3 | 8 | | ● | | | | ● | | | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | 4 | 8 | | ● | | | | ● | ● | ● | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | #2 & #3 MOTORS CUTOUT | 1 | 1 | | | ● | | ● | ● | | | ● | | ● | ● | ● | | | | | | ● | ● | |
| | | | 8 | | | ● | | ● | ● | | | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | 2 | 8 | | | ● | | ● | ● | ● | ● | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | 3 | 8 | | | ● | | ● | ● | | | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | 4 | 8 | | | ● | | ● | ● | ● | ● | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| ELECTRIC BRAKING | | B | IDLE | ● | ● | | | ● | ● | | | ● | | ● | ● | ● | | | | | ● | ● | ● | |
| M.U. ENG. STOP | ANY | ANY | ANY | DEPEND ON HANDLE POSITIONS | | | | | | | | | | | | | | | | ● | ○ | | | ● |
| ENG. STOP BY EC SWITCH | ANY | ANY | ANY | | | | | | | | | | | | | | | | | | | | | |

1500-HP ROAD LOCOMOTIVE
without
Dynamic Braking

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## SEQUENCE TABLE

| OPERATION | MOTOR CONNECTION | SH SELECTOR HANDLE POSITION | TH THROTTLE HANDLE NOTCH | EC-ENG. CONT. SW. | SW-BRAKING SW. | CONTACTORS | | | | | | | | | | | | RELAYS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | S1 | P1-P21 | P2 | S21 | P22 | TDR | M1 | M2,M3,M4 | TR | GS1,GS2 | FPC | EF | DMR | AVF,AVS | BVS | CVF,CVS | DVS | BR1,BR2 | GF | OPR | ESR |
| SHUT DOWN | CONT. SW. OPEN | OFF | IDLE | O | B | | | | | | | | | | | | | | | | | | | | | |
| ENG. START | CONT. SW. CLOSED | OFF | IDLE | S | B | | | | | | | | | | ● | ● | | | | | | | | | | |
| IDLING | CONT. SW. CLOSED | OFF | IDLE | I | B | | | | | | | | | | | ● | | ● | | | | | | | ● | |
| MOTORING | SERIES | 1 | 1 | R | M | ● | | | ● | | ● | | | | | ● | ● | ● | | | | | | ● | ● | |
| | | | 2 | R | M | ● | | | ● | | ● | | | | | ● | ● | ● | ● | | | | | ● | ● | |
| | | | 3 | R | M | ● | | | ● | | ● | | | | | ● | ● | ● | | | ● | | | ● | ● | |
| | | | 4 | R | M | ● | | | ● | | ● | | | | | ● | ● | ● | ● | | ● | | | ● | ● | |
| | | | 5 | I | M | ● | | | ● | | ● | | | | | ● | ● | ● | | ● | ● | ● | | ● | ● | |
| | | | 6 | R | M | ● | | | ● | | ● | | | | | ● | ● | ● | ● | ● | ● | ● | | ● | ● | |
| | | | 7 | R | M | ● | | | ● | | ● | | | | | ● | ● | ● | | ● | ● | | | ● | ● | |
| | | | 8 | R | M | ● | | | ● | | ● | | | | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | SERIES FS2 | 2 | 8 | R | M | ● | | | ● | | ● | ● | | | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | | | R | M | ● | | | ● | | ● | ● | ● | | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | FORWARD TRANSITION (2 TO 3) | 3 | 8 | R | M | ● | | | ● | | ● | ● | ● | | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | | | R | M | ● | | | ● | | ● | | | | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | | | R | M | ● | | | ● | | ● | | | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | | | R | M | ● | | | ● | | ● | | | ● | | ● | ● | ● | ● | ● | ● | | | | ● | |
| | | | | R | M | ● | ● | | ● | | ● | | | ● | | ● | | ● | ● | ● | ● | | | | ● | |
| | | | | R | M | | ● | | | | ● | | | ● | | ● | | ● | ● | ● | ● | | | | ● | |
| | | | | R | M | | ● | ● | | ● | ● | | | ● | | ● | | ● | ● | ● | ● | | | | ● | |
| | PARALLEL | 3 | 8 | R | M | | ● | ● | | ● | ● | | | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | | 7 | R | M | | ● | ● | | ● | ● | | | ● | | ● | ● | ● | | ● | ● | | | ● | ● | |
| | | | 8 | R | M | | ● | ● | | ● | ● | | | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | PARALLEL FS2 | 4 | 8 | R | M | | ● | ● | | ● | ● | ● | | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | | | R | M | | ● | ● | | ● | ● | ● | ● | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | BACKWARD TRANSITION (3 TO 2) | 2 | 8 | R | M | | ● | ● | | ● | ● | | | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | | | R | M | | | ● | | ● | ● | | | | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | | | R | M | ● | | ● | ● | ● | ● | | | | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | | | R | M | ● | | | ● | | ● | | | | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | | | R | M | ● | | | ● | | ● | ● | | | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | SERIES FS2 | 2 | 8 | R | M | ● | | | ● | | ● | ● | ● | | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | SERIES FS1 | 1 | 8 | R | M | ● | | | ● | | ● | | | | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| IDLING | | 1 TO 4 | IDLE | R | M | | | | | | | | | | | ● | | ● | | | | | | | ● | |
| CUTOUT MOTORING | #1 & #4 MOTORS CUTOUT | 1 | 1 | R | M | | ● | | | | ● | | | ● | | ● | ● | ● | | | | | | ● | ● | |
| | | | 8 | R | M | | ● | | | | ● | | | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | 2 | 8 | R | M | | ● | | | | ● | ● | ● | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | 3 | 8 | R | M | | ● | | | | ● | | | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | 4 | 8 | R | M | | ● | | | | ● | ● | ● | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | #2 & #3 MOTORS CUTOUT | 1 | 1 | R | M | | | ● | | ● | ● | | | ● | | ● | ● | ● | | | | | | ● | ● | |
| | | | 8 | R | M | | | ● | | ● | ● | | | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | 2 | 8 | R | M | | | ● | | ● | ● | ● | ● | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | 3 | 8 | R | M | | | ● | | ● | ● | | | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| | | 4 | 8 | R | M | | | ● | | ● | ● | ● | ● | ● | | ● | ● | ● | ● | ● | ● | | | ● | ● | |
| ELECTRIC BRAKING | | B | IDLE | R | B | ● | ● | | | ● | ● | | | ● | | ● | ● | ● | | | | | ● | ● | ● | |
| M.U. ENG. STOP | ANY | ANY | ANY | R OR I | M OR B | DEPEND ON HANDLE POSITIONS | | | | | | | | | | | | | | | | ● | ○ | | | ● |
| ENG. STOP BY EC SWITCH | ANY | ANY | ANY | O | M OR B | | | | | | | | | | | | | | | | | | | | | |

1500-HP ROAD LOCOMOTIVE
with
Dynamic Braking

## SEQUENCE TABLE

| OPERATION | MOTOR CONNECTION | SELECTOR HANDLE POSITION SH | THROTTLE HANDLE NOTCH TH | EC-ENG. CONT. SW. | | CONTACTORS | | | | | | | | | | RELAYS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | S1 | P1-P21 | P2 | S21 | P22 | TDR | TR | GS1, GS2 | CS | EP | DMR | AVF, AVS | BVS | CVF, CVS | DVS | BR1, BR2 | GF | OPR | ESR | CR1 | CR2 | CR3 |
| SHUT DOWN | CONT. SW. OPEN | OFF | IDLE | O | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ENG. START | CONT. SW. CLOSED | OFF | IDLE | S | |  |  |  |  |  |  |  | ● |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| IDLING | CONT. SW. CLOSED | OFF | IDLE | I | |  |  |  |  |  |  |  |  |  |  | ● |  |  |  |  |  |  | ● |  |  |  |  |
| MOTORING | SERIES | 4 | 1 | R | | ● |  |  | ● |  | ● |  |  |  | ● | ● |  |  |  |  |  | ● | ● |  |  |  |  |
| | | | 2 | R | | ● |  |  | ● |  | ● |  |  |  | ● | ● | ● |  |  |  |  | ● | ● |  |  |  |  |
| | | | 3 | R | | ● |  |  | ● |  | ● |  |  |  | ● | ● |  |  | ● |  |  | ● | ● |  |  |  |  |
| | | | 4 | R | | ● |  |  | ● |  | ● |  |  |  | ● | ● | ● |  | ● |  |  | ● | ● |  |  |  |  |
| | | | 5 | R | | ● |  |  | ● |  | ● |  |  |  | ● | ● |  | ● | ● | ● |  | ● | ● |  |  |  |  |
| | | | 6 | R | | ● |  |  | ● |  | ● |  |  |  | ● | ● | ● | ● | ● | ● |  | ● | ● |  |  |  |  |
| | | | 7 | R | | ● |  |  | ● |  | ● |  |  |  | ● | ● |  | ● | ● |  |  | ● | ● |  |  |  |  |
| | | | 8 | R | | ● |  |  | ● |  | ● |  |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  |  |  |  |
| | SERIES FS2 | 4 | 8 | R | | ● |  |  | ● |  | ● |  |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● |  |  |
| | | | | R | | ● |  |  | ● |  | ● |  |  | ● | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● |  |  |
| | FORWARD TRANSITION (2 TO 3) | 4 | 8 | R | | ● |  |  | ● |  | ● |  |  | ● | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● |  |
| | | | | R | | ● |  |  | ● |  | ● |  |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● |  |
| | | | | R | | ● |  |  | ● |  | ● | ● |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● |  |
| | | | | R | | ● |  |  | ● |  | ● | ● |  |  | ● | ● | ● | ● | ● |  |  |  | ● |  | ● | ● |  |
| | | | | R | | ● | ● |  | ● |  | ● | ● |  |  |  | ● | ● | ● | ● |  |  |  | ● |  | ● | ● |  |
| | | | | R | |  | ● |  |  |  | ● | ● |  |  |  | ● | ● | ● | ● |  |  |  | ● |  | ● | ● |  |
| | | | | R | |  | ● | ● |  | ● | ● | ● |  |  |  | ● | ● | ● | ● |  |  |  | ● |  | ● | ● |  |
| | PARALLEL | 4 | 8 | R | |  | ● | ● |  | ● | ● | ● |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● |  |
| | | | 7 | R | |  | ● | ● |  | ● | ● | ● |  |  | ● | ● |  | ● | ● |  |  | ● | ● |  | ● | ● |  |
| | | | 8 | R | |  | ● | ● |  | ● | ● | ● |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● |  |
| | PARALLEL FS2 | 4 | 8 | R | |  | ● | ● |  | ● | ● | ● |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● | ● |
| | | | | R | |  | ● | ● |  | ● | ● | ● |  | ● | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● | ● |
| | BACKWARD TRANSITION (3 TO 2) | 4 | 8 | R | |  | ● | ● |  | ● | ● | ● |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● |  |
| | | | | R | |  | ● | ● |  | ● | ● | ● |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● |  |  |
| | | | | R | |  |  | ● |  | ● | ● |  |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● |  |  |
| | | | | R | | ● |  | ● | ● | ● | ● |  |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● |  |  |
| | | | | R | | ● |  |  | ● |  | ● |  |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● |  |  |
| | SERIES FS2 | 4 | 8 | R | | ● |  |  | ● |  | ● |  |  | ● | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● |  |  |
| | SERIES FS1 | 4 | 8 | R | | ● |  |  | ● |  | ● |  |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  |  |  |  |
| IDLING | | 1 TO 4 | IDLE | R | |  |  |  |  |  |  |  |  |  |  | ● |  |  |  |  |  |  | ● |  |  |  |  |
| CUTOUT MOTORING | #1 & #4 MOTORS CUTOUT | 1 | 1 | R | |  | ● |  |  |  | ● | ● |  |  | ● | ● |  |  |  |  |  | ● | ● |  |  |  |  |
| | | | 8 | R | |  | ● |  |  |  | ● | ● |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  |  |  |  |
| | | 2 | 8 | R | |  | ● |  |  |  | ● | ● |  | ● | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● |  |  |
| | | 3 | 8 | R | |  | ● |  |  |  | ● | ● |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● |  |
| | | 4 | 8 | R | |  | ● |  |  |  | ● | ● |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● |  |
| | #2 & #3 MOTORS CUTOUT | 1 | 1 | R | |  |  | ● |  | ● | ● | ● |  |  | ● | ● |  |  |  |  |  | ● | ● |  |  |  |  |
| | | | 8 | R | |  |  | ● |  | ● | ● | ● |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  |  |  |  |
| | | 2 | 8 | R | |  |  | ● |  | ● | ● | ● |  | ● | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● |  |  |
| | | 3 | 8 | R | |  |  | ● |  | ● | ● | ● |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● |  |
| | | 4 | 8 | R | |  |  | ● |  | ● | ● | ● |  | ● | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● | ● |
| | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| M.U. ENG. STOP | ANY | ANY | ANY | R OR I | M OR B |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ● |  |  |  | ● |  |  |  |
| ENG. STOP BY EC SWITCH | ANY | ANY | ANY | O | M OR B |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**2000-HP ROAD LOCOMOTIVE**
without
Dynamic Braking

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## SEQUENCE TABLE

| OPERATION | MOTOR CONNECTION | SELECTOR HANDLE POSITION SH | THROTTLE HANDLE NOTCH TH | EC-ENG. CONT. SW. | SW-BRAKING SW. | CONTACTORS | | | | | | | | | | RELAYS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | S1 | P1-P21 | P2 | S21 | P22 | TDR | TR | GS1, GS2 | CS | EP | DMR | AVF, AVS | BVS | CVF, CVS | DVS | BR1, BR2 | GF | OPR | ESR | CR1 | CR2 | CR3 |
| SHUT DOWN | CONT. SW. OPEN | OFF | IDLE | O | B |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ENG. START | CONT. SW. CLOSED | OFF | IDLE | S | B |  |  |  |  |  |  |  | ● |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| IDLING | CONT. SW. CLOSED | OFF | IDLE | I | B |  |  |  |  |  |  |  |  |  |  | ● |  |  |  |  |  |  | ● |  |  |  |  |
| MOTORING | SERIES | 4 | 1 | R | M | ● |  |  | ● |  | ● |  |  |  | ● | ● |  |  |  |  |  | ● | ● |  |  |  |  |
| | | | 2 | R | M | ● |  |  | ● |  | ● |  |  |  | ● | ● | ● |  |  |  |  | ● | ● |  |  |  |  |
| | | | 3 | R | M | ● |  |  | ● |  | ● |  |  |  | ● | ● |  |  | ● |  |  | ● | ● |  |  |  |  |
| | | | 4 | R | M | ● |  |  | ● |  | ● |  |  |  | ● | ● | ● |  | ● |  |  | ● | ● |  |  |  |  |
| | | | 5 | R | M | ● |  |  | ● |  | ● |  |  |  | ● | ● |  | ● | ● | ● |  | ● | ● |  |  |  |  |
| | | | 6 | R | M | ● |  |  | ● |  | ● |  |  |  | ● | ● | ● | ● | ● | ● |  | ● | ● |  |  |  |  |
| | | | 7 | R | M | ● |  |  | ● |  | ● |  |  |  | ● | ● |  | ● | ● |  |  | ● | ● |  |  |  |  |
| | | | 8 | R | M | ● |  |  | ● |  | ● |  |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  |  |  |  |
| | SERIES FS2 | 4 | 8 | R | M | ● |  |  | ● |  | ● |  |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● |  |  |
| | | | | R | M | ● |  |  | ● |  | ● |  |  | ● | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● |  |  |
| | FORWARD TRANSITION (2 TO 3) | 4 | 8 | R | M | ● |  |  | ● |  | ● |  |  | ● | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● |  |
| | | | | R | M | ● |  |  | ● |  | ● |  |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● |  |
| | | | | R | M | ● |  |  | ● |  | ● | ● |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● |  |
| | | | | R | M | ● |  |  | ● |  | ● | ● |  |  | ● | ● | ● | ● | ● |  |  |  | ● |  | ● | ● |  |
| | | | | R | M | ● | ● |  | ● |  | ● | ● |  |  |  | ● | ● | ● | ● |  |  |  | ● |  | ● | ● |  |
| | | | | R | M |  | ● |  |  |  | ● | ● |  |  |  | ● | ● | ● | ● |  |  |  | ● |  | ● | ● |  |
| | | | | R | M |  | ● | ● |  | ● | ● | ● |  |  |  | ● | ● | ● | ● |  |  |  | ● |  | ● | ● |  |
| | PARALLEL | 4 | 8 | R | M |  | ● | ● |  | ● | ● | ● |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● |  |
| | | | 7 | R | M |  | ● | ● |  | ● | ● | ● |  |  | ● | ● |  | ● | ● |  |  | ● | ● |  | ● | ● |  |
| | | | 8 | R | M |  | ● | ● |  | ● | ● | ● |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● |  |
| | PARALLEL FS2 | 4 | 8 | R | M |  | ● | ● |  | ● | ● | ● |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● | ● |
| | | | | R | M |  | ● | ● |  | ● | ● | ● |  | ● | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● | ● |
| | BACKWARD TRANSITION (3 TO 2) | 4 | 8 | R | M |  | ● | ● |  | ● | ● | ● |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● |  |
| | | | | R | M |  | ● | ● |  | ● | ● | ● |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● |  |  |
| | | | | R | M |  |  | ● |  | ● | ● |  |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● |  |  |
| | | | | R | M | ● |  | ● | ● | ● | ● |  |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● |  |  |
| | | | | R | M | ● |  |  | ● |  | ● |  |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● |  |  |
| | SERIES FS2 | 4 | 8 | R | M | ● |  |  | ● |  | ● |  |  | ● | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● |  |  |
| | SERIES FS1 | 4 | 8 | R | M | ● |  |  | ● |  | ● |  |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  |  |  |  |
| IDLING | | 1 TO 4 | IDLE | R | M |  |  |  |  |  |  |  |  |  |  | ● |  |  |  |  |  |  | ● |  |  |  |  |
| CUTOUT MOTORING | #1 & #4 MOTORS CUTOUT | 1 | 1 | R | M |  | ● |  |  |  | ● | ● |  |  | ● | ● |  |  |  |  |  | ● | ● |  |  |  |  |
| | | | 8 | R | M |  | ● |  |  |  | ● | ● |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  |  |  |  |
| | | 2 | 8 | R | M |  | ● |  |  |  | ● | ● |  | ● | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● |  |  |
| | | 3 | 8 | R | M |  | ● |  |  |  | ● | ● |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● |  |
| | | 4 | 8 | R | M |  | ● |  |  |  | ● | ● |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● |  |
| | #2 & #3 MOTORS CUTOUT | 1 | 1 | R | M |  |  | ● |  | ● | ● | ● |  |  | ● | ● |  |  |  |  |  | ● | ● |  |  |  |  |
| | | | 8 | R | M |  |  | ● |  | ● | ● | ● |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  |  |  |  |
| | | 2 | 8 | R | M |  |  | ● |  | ● | ● | ● |  | ● | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● |  |  |
| | | 3 | 8 | R | M |  |  | ● |  | ● | ● | ● |  |  | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● |  |
| | | 4 | 8 | R | M |  |  | ● |  | ● | ● | ● |  | ● | ● | ● | ● | ● | ● |  |  | ● | ● |  | ● | ● | ● |
| ELECTRIC BRAKING | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| | | B | IDLE | R | B | ● | ● |  |  | ● | ● | ● |  |  | ● | ● |  |  |  |  | ● | ● | ● |  |  |  |  |
| M.U. ENG. STOP | ANY | ANY | ANY | R OR I | M OR B |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ● | ○ |  |  | ● |  |  |  |
| ENG. STOP BY EC SWITCH | ANY | ANY | ANY | O | M OR B |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**2000-HP ROAD LOCOMOTIVE**
with
Dynamic Braking

## NOTES

# ELECTRIC SYSTEMS

## POWER-PLANT REGULATING SYSTEM

### PROTECTIVE DEVICES

Contacts on governor oil-pressure switch (GOP) will open if pressure falls to 75 pounds or lower. The clutch coil in governor will be de-energized, releasing clutch which will cause engine to shut down.

Loss of governor speed-coil current drops out safety relay (SAR). The clutch will be de-energized, releasing clutch which will cause engine to shut down.

A drop in engine lubricating-oil pressure below 20 pounds will open OPS contacts which will de-energize OPR relay and return engine to idle in the 5th, 6th, 7th or 8th throttle notches.

Further drop in engine oil pressure to seven pounds or below opens OPS2 which de-energizes the clutch coil shutting down the engine in all throttle notches.

If a traction motor must be cut out due to a failure, the generator and the remaining motors are protected against overloading by opening motor cut-out switch (CO). This will insert additional resistance in the maximum fuel-limit trimming resistor and reduce the engine power to a safe value.

Engine overspeed protection is furnished by the centrifugal switch (OS) set for 10 per cent above the rated engine speed. Overspeeding of the engine will open the clutch-coil circuit through OS shutting down the engine.

### LUBRICATION

Keep governor oil-supply reservoir two-thirds full or oil level in sight glass one-half full using SAE-10W non-detergent automotive oil.

## INSPECTION

Check for oil leaks at pipe line connections, gasket between base and frame, pipe plugs that seal the drilled passageways, oil seals at end of fuel-limit and main piston shafts.

Check wiring, making sure all connections are tight.

Check each rheostat brush arm by lifting spring and noting if both brushes rest on commutator and slip ring. If not, remove brush arm and bend arm toward commutator.

Check speed-control solenoid current (.475 ampere) by inserting an ammeter in the solenoid circuit. This may be done by connecting in at terminal 31T in the connection box below the engine control panel.

Check fuel-limit solenoid current (.475 ± .005 ampere) by inserting an ammeter in the solenoid circuit. This may be done by connecting in at terminal 50C in the connection box below the engine control panel.

## GOVERNOR ADJUSTMENTS

### LOAD-CONTROL RHEOSTAT

With no oil pressure, and circuits de-energized, brush arm should be on the blank section of commutator and adjacent to active section that requires CCW motion to enter. Be sure brush arm is secure on shaft and against snap ring.

### FUEL-LIMIT RHEOSTAT

With full oil pressure, and circuits de-energized, brush arm should be on the blank section of the commutator adjacent to active section that requires CCW motion to enter.

Depress pilot valve on fuel-limit solenoid. Brush arm should move CCW across active section and just enter blank section on opposite end. Be sure brush arm is secure on shaft and against snap ring.

### STABILIZING RHEOSTAT

With full oil pressure, depress speed solenoid. Brush arm should be on blank section adjacent to active section that requires CCW motion to enter. Release speed solenoid. Brush arm should travel CCW across active section stopping about 3/4 of the active section. The fuel-limit pilot valve must be depressed to complete brush-arm travel and just enter blank section at opposite end. Be sure brush arm is secure on shaft and against snap ring.

### OIL PRESSURE

1. Place an oil-pressure gage capable of reading over 125 pounds per square inch in the pressure side of the oil line between the governor and governor oil pump.

2. Facing governor rheostats remove hexagonal plug and washer on right-hand side of base.

3. With oil pressure on, adjust slotted plug to obtain 125 pounds per square inch reading on gage.

4. Replace hexagonal plug and washer and remove pressure gage.

## CONTROL PANEL ADJUSTMENTS

Adjustment of speed-setting rheostats for correct engine speeds is accomplished by setting throttle on control stand and adjusting corresponding rheostat on engine control panel. Setting is made by loosening lock screw and adjusting rheostat until desired engine rpm is obtained.

The throttle handle may be moved to any of the eight throttle notches by placing the reverse handle in OFF position and the selector handle in position 1.

Throttle notches and the corresponding rheostats are:

| THROTTLE NOTCH | ENGINE RPM | RHEOSTAT |
|---|---|---|
| Idle | 350 | 132 |
| 1 | 350 | 132 |
| 2 | 450 | 132A |
| 3 | 550 | 132B |
| 4 | 655 | 132C |
| 5 | 765 | 132D |
| 6 | 860 | 132E |
| 7 | 920 | 132F |
| 8 | 1000 | 132G |
| Overspeed | 1100-1120 | 132H |

Fuel-limit trimming for IDLE notch and 8th notch is accomplished by means of rheostats 124A, 124 and 161.

The stabilizing rheostat should be adjusted for a minimum of hunting, which is indicated by fast fluctuation of the stabilizing rheostat brush arm. This adjustment can only be made in the first two throttle notches.

Mechanical linkage from the governor to the fuel racks should be adjusted for full power output into a water box or similar testing device. Linkage should also cause the engine fuel-control rack pointers to indicate approximately 3.5 mm when the engine is shut down.

Adjustment is made by loosening lock nut on clevis tongue and screwing tongue in or out as desired. Tighten lock nut after adjustment is made.

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## GOVERNOR DRY RUN

1. Block engine-starting contactors (GS1 and GS2) open with wooden wedges between armature and core of each contactor. Block blower stopped relay (BLR) closed. There is no blower stopped relay on 1500-hp road switchers.

2. Close battery switch 100, control breakers 136, both fuel-pump breakers, M-G set breaker, and other engine auxiliary breakers. Make sure fuel and governor oil is available with pressure maintained by pump. Have throttle handle in IDLE notch.

3. Turn engine-control switch (EC) to IDLE. Alarm gong should ring and low lube-oil light come on. After load-control and stabilizing rheostat brush arms reach their new position (pointing at five o'clock) close engine-start switch (ECS).

4. Hold engine-start switch closed. Block lube-oil pressure switch (OPS2) closed. Oil-pressure control relay (OPR) should pick up, alarm gong stop ringing, and low lube-oil lights go out. Block safety relay (SAR) closed. Release engine-start switch. Turn engine control switch (EC) to RUN.

5. Remove block from blower stopped relay (BLR). Alarm gong should ring and blower off light come on. Replace block.

6. Notch throttle handle up slowly. Fuel racks should move out a bit for each higher throttle notch until notch 5 is reached. Oil-pressure control relay (OPR) should drop out, alarm gong should ring, and low lube-oil pressure light come on.

7. Block low lube-oil pressure switch (OPS1) closed. Oil-pressure control relay (OPR) should pick up, alarm gong stop ringing, and low lube-oil pressure light go out.

8. Move throttle handle to notch 8.

9. Open safety relay (SAR), governor clutch coil should be de-energized, and engine fuel-control racks return to shut-down position.

10. Repeat steps 3, 4, 6, 7, and 8. Pull out reset button on engine overspeed switch (OS). Governor clutch coil should be de-energized, and engine fuel-control racks return to shut-down position. Reset overspeed switch (OS) by pushing in on reset button.

11. Repeat steps 3, 4, 6, 7, and 8. Open fuel-pump circuit breaker. When governor oil pressure drops, governor oil-pressure switch (GOP) should open and de-energize governor clutch coil returning engine fuel-control racks to shut-down position.

12. Close fuel-pump circuit breaker. Repeat steps 3, 4, 6, 7, and 8. Remove block from low lube-oil pressure switch (OPS2), allowing its contacts to open. Governor clutch coil should become de-energized and engine fuel-control racks should return to shut-down position. Alarm gong should ring and low lube-oil pressure light come on.

13. Replace block in low lube-oil pressure switch (OPS2). Repeat steps 3, 4, 6, 7, and 8. Push engine-stop button on control stand. The governor clutch coil should be de-energized returning engine fuel-control racks to shut-down position.

14. If maximum engine fuel-control rack readings are desired, repeat steps 3, 4, 6, 7, and 8. Remove cover from governor and cap from fuel-limit solenoid pilot valve. Press solenoid plunger down until fuel-limit rheostat brush arm reaches the last commutator segment. Brush arm should be pointing at about seven o'clock. Replace cap on fuel-limit solenoid pilot valve when this check is completed.

15. Return throttle handle to IDLE. Remove blocks from low lube-oil pressure switches (OPS1 and OPS2) and safety relay (SAR). Make sure safety relay opens. Remove blocks from starting contactors (GS1 and GS2). Remove block from blower stopped relay (BLR).

## ENGINE OVERSPEED SWITCH

### MAINTENANCE DATA

Engine Trip Speed - - - - - - - - 1100-1120 RPM
Rotor Speed - - - - - - (1 to 3.420) 3762-3830 RPM
Contact Gap - - - - - - - - - - - 3/16-1/4 in.
Contact Pressure - - - - - - - - - - - - 8 ounces
Clearance between weight and
switch - not tripped - - - - - - - - 1/64-1/32 in.
Weight Travel - - - - - - - - - - - - - - 9/32 in.

### ADJUSTMENT

Remove oblong cover plate on switch housing. Engine may have to be barred over to bring adjusting nut around to opening. Before making any adjustment, loosen set screw which holds adjusting nut in place on shaft. A tool which fits the adjusting nut may be ordered by Catalog No. 8827792G1.

Turning adjusting nut inward decreases tension on inner spring and shuts engine down at a lower maximum speed.

Turning adjusting nut outward increases tension on inner spring and shuts engine down at a higher maximum speed.

Settings may be checked by the following method:

1. Make certain generator-field switch is in OFF position.

2. Place reverse handle in OFF position.

3. Place selector handle in position 1.

4. With engine running, and engine-control switch in RUN position, pull throttle back to notch 8.

5. Increase engine speed gradually, by turning IN on rheostat 132H, until weight mechanism trips engine overspeed switch and shuts down engine.

NOTE: Watch engine speed indicator on engine-control panel to be sure engine does not exceed the permissible engine overspeed. On 1500-hp road switchers an engine speed indicator may be plugged in a receptacle on governor rectifier panel in control compartment.

## VOLTAGE-CONTROL SYSTEM

### VOLTAGE SETTING

Universal setting should be 75 volts, as indicated on locomotive battery voltmeter, subject to check with a test instrument of known accuracy.

If daily record of battery gravity and pilot-cell water consumption indicate excessive charging, reduce setting by not more than 1 volt. Do not make further reductions unless subsequent records of battery condition indicate the need, then make another 1-volt reduction. See battery manufacturer's instructions for further advice on voltage setting.

When changing settings, check voltage at high engine speed, adjusting high-speed rheostat as required. Then equalize the voltage at idle engine speed with the idle speed rheostat.

### REPAIRS

Do not replace a contact finger without making certain that possible projections of built-up material have been removed from the surface of the contact bar. This will help to avoid improper sequence of contact operation.

Transferred or built-up material on contact surfaces should normally be removed after each 1500 hours of operation, unless experience proves otherwise.

This transferred material may be removed by a few light strokes of a clean, fine file. It is not necessary to file out corresponding craters. Never use abrasives, such as emery or carborundum, since fine particles may become imbedded in the silver alloy, interfering with making a good contact. Never attempt to clean contacts unless the device is de-energized.

If individual contact fingers show signs of severe burning or blackening, the cause should be remedied. The most frequent causes are the failure of the adjacent contact finger to make good contact with the bar due to imbedded foreign particles, excessive dirt or oil; or a broken resistor connection.

When replacing a contact bar make sure the slope is in proper direction as indicated by "Front" and "Back" stamped on ends of bar. Contact bar slope is 1/8 inch, thin end at front.

After replacement of a bar or finger, check contact sequence, gaps and wipes, as floating coils move in and out. See DATA for correct gaps and wipes. Do not shim bar or bend fingers, adjust hexagon-support studs.

Contact fingers are interchangeable. Note order of assembly of shield, finger, terminal, washer, lock washer and screw. Incorrect assembly will throw contact finger out of line. Check each finger for free-hinge action.

Move floating coil slowly in and out by hand. See that fingers on each block contact the bar in regular sequence. Opposite pairs of fingers should contact the bar at approximately the same time. Exact synchronism is not necessary.

## DATA

| | 17LH28B2 | 17LH28J7 |
|---|---|---|
| Generator | GY24 | GY27 |
| Nominal Volts | 75 ± 3 Volts | |
| Voltage Adjustable - Contr. Rheo. | 70-80 Volts | |
| Shunt Fld. Resistance (Hot) | 11.1 ohms | 8.3 ohms |
| Shunt Fld. Resistance (25 C) | 9.3 ohms | 5.8 ohms |
| Rated Fld. Amp. Range | .398-6.38 | .986-7.86 |
| Float Shunt Amp. (at top speed) | .85-.91 | .8-.82 |
| Current Limit Coil Resistance | .0337 ohm | |
| Tip Gap (bar down against stop) | | |
| Back Contacts | .031 in. | |
| Front Contacts | .156 in. | |
| Wipe (bar out against stop) | | |
| Back Contacts | .156 in. | |
| Front Contacts | .031 in. | |

## MOVING COILS

Total floating-coil travel is 3/16 inch. Check floating and current-limit coils at regular intervals for central location in their air gaps. Normal clearance is approximately 1/16 inch at all points. If the clearance is considerably less, it should be corrected to avoid possible errors in the electrical settings. There should be no rubbing or friction at any point in the normal travel. Floating-coil springs and the spring post should operate clear of all stationary parts.

Examine spring-steel supporting fingers and flexible braided copper shunts for mechanical damage or possible corrosion.

Make sure attaching screws at both ends of supporting fingers are tight.

## MAGNETIC ADJUSTING PLUG

Flat compounding is accomplished by means of a magnetic trimmer adjusting plug screwed in the upper

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face of the floating coil. If a floating coil must be replaced install the plug in exactly the same position in the new coil. If the plug is screwed in too far, the relay will hold a low voltage at high speed with some pumping action as a result.

## RADIATOR FAN CONTROL SYSTEM

Automatic or manual operation of the temperature control relay is made possible by means of a toggle switch located inside the relay panel cover.

With switch in manual position, the knurled rheostat disk, projecting through the cover, may be moved to any position for setting desired fan speed.

## LUBRICATION

The motor and gear box were assembled as a unit and tested for gear friction which might affect motor rheostat timing. The motor and gear box should be replaced as a unit. Do not replace motor or gears in the field.

The unit has been permanently greased, and unless signs of leakage are noticed no grease should be added. If it becomes necessary to disassemble the gear box, remove all old grease and repack gear box with 1/3 pound of G.E. PC No. 2 grease or equivalent.

## MOTOR, GEAR BOX AND CLUTCH

This assembly can be removed as a unit. Remove panel leads from motor terminal board and the 1/4-20 capscrews holding gear box to frame.

Motor commutator and slip rings should be clean with no signs of burning. Each brush should have a minimum of 2 pounds pressure.

The dial clutch surface must be kept free of oil or other lubricants. After cleaning, if the clutch still slips, rough the dial surface with emery cloth. The dial must have positive clearance from the panel door throughout the entire range of dial movement.

## LIMIT SWITCHES

Three cams at the lower end of dial shaft operate the limit switches. The dial should open the top limit switch, and close the middle limit switch at the "OFF" position, with 1/8 inch or more gap, before dial hits its stop. Middle switch must definitely close before top switch contacts part, to assure shutter operation before dial stops.

The dial should also operate bottom switch, with 1/8 inch or more gap, before dial hits stop at point 20.

## BELLOWS OPERATION

The bellows arm must stop on the internal bellows stop with the bellows bulb cold (below 120 F). The bellows should raise the arm to the top stop at 160 F on the bellows bulb. Make sure the pointed bellows push rod is centered in the socket in the bellows actuating arm.

Check bellows travel by using heated water on bulb, if removed from water line; or allow engine to idle with fan turned off (switch on MANUAL and dial OFF) and bulb in place until the above temperature is reached. Temperatures over 212 F (boiling water) on bulb will permanently injure the bellows. Do not heat bulb with an open flame.

The bulb may be removed from water line without draining the system as the bulb is set in a dry well. This well should contain enough light oil to cover bulb when it is fully inserted. The 1/32 inch washer must be in place between the dry well flange and shoulder on bulb. Excessive tightening on gland nut will swell and jam bulb, preventing its removal.

## BIMETAL HEATERS

These assemblies are attached to the relay frame by capscrews through slotted holes in their supports. This allows shifting the assembly to obtain correct setting on left bimetal arm. The right bimetal arm is pivoted at a point below the right heater with an adjusting screw below the pivot.

Set left bimetal arm at approximately 70-80 F to contact bellows arm extension when floating contact is 3/32 inch from left or lower fixed contact.

Set right bimetal arm to contact bellows arm extension when floating contact is 1/32 inch from right or top fixed contact.

## FIXED CONTACT ADJUSTMENT

With floating contact clear of fixed contacts, fixed contacts should be held by armature spring so that locked nuts on contact stud are against inner surface of bronze spring stop.

Set armature gaps, with coil de-energized, by adjusting locked nuts on contact studs so that with coil energized (armature pulled in) contact travel will be .015 to .025 inch. This travel must be checked by energizing coil. Raise bellows arm by hand to top contact and observe lower contact, and vice versa.

When contacts are new, the wipe is 1/16 inch top and bottom, with lever down against internal bellows stop nut.

When wipe is reduced to approximately .010 inch by contact wear, tips should be replaced.

## FLOATING CONTACT ADJUSTMENT

Approximately 10 to 15 F temperature adjustment is provided by the relay tension springs operating on the contact arm. Increasing the spring tension raises the temperature setting. Set both springs approximately the same.

Do not disturb slotted clamp screws or adjusting screw between the pair of springs. This setting was made for the correct amount of differential between "ON" and "OFF". The differential is between 2 and 4 F as registered on a thermometer located adjacent to the bulb well in water line. To check this it is necessary to have a very slow rate of temperature change, less than 2 degrees per minute.

An approximate check may be made by idling engine with fan OFF, allowing the temperature to rise slowly through the operating range of the relay. Read temperature when floating contact leaves the bottom stationary contact and again when it reaches the top stationary contact. Very slow rates of temperature rise (engine idling) may be read on engine panel motometer.

## TROUBLE SHOOTING

**Faulty Clutch Excitation** - Insert an ammeter in number 72 wire at relay terminal board and operate commutator dial by hand. Current should vary from approximately .15 ampere at point 1 to 10 amperes at point 20. If no current is found, check interlock on radiator shutter operating mechanism, the rheostat, clutch coil continuity, and the supply circuit breakers.

**Faulty Rheostat Motor Operation** - If clutch excitation is satisfactory, the rheostat motor circuits should be checked with the panel switch in automatic position by operating the bellows arm and contacts by hand. Raise arm to make top (right) contact. Dial should run from "OFF" to point "20". Lower arm to make bottom (left) contact. Dial should run back to "OFF".

Limit switches on the commutator dial assembly should stop the motor when dial reaches the end of its travel. If the motor runs with floating contact not in contact with either stationary contact, check capacitors above contact assembly for internal shorting.

**Faulty Bellows Operation** - Check by idling engine with fan control panel switch in manual position. At 160 F, or less, on engine motometer the bellows should raise the arm against the stop nut, and should have forced the top (right) fixed contact to wipe the floating contact finger by 1/16 inch if contacts are new, less if contacts are worn.

Failure to wipe this contact indicates misadjustment of fixed contacts, or excessive contact wear. Failure to respond at all to temperature change indicates loss of fluid from bulb-bellows system.

## FIELD SHUNTING CONTROL SYSTEM

## LUBRICATION

**Motor-Oilite Bushing Shaft End** - Saturate wicks in motor pilot with machine oil about once a year.

**Gear Case** - One half pound G-E PC No. 2 grease when repacked.

**Main Finger Rollers** - "A" Forms - One or two drops of oil at each inspection period.

"B" and "C" Forms - No lubricant necessary unless signs of rusting are noted.

**Interlock Rollers** - No lubricant necessary unless signs of rusting are noted.

**Armature Rollers** - Few drops of oil monthly.

## SHUNTING SEQUENCE

| STEP | CONTACTS CLOSED | STEP | CONTACTS CLOSED |
|---|---|---|---|
| 1 | 1 | 10 | 1, 2, 3, 5 |
| 2 | 2 | 11 | 1, 2, 4, 5 |
| 3 | 1, 2 | 12 | 1, 3, 4, 5 |
| 4 | 1, 3 | 13 | 1, 2, 3, 4, 5 |
| 5 | 2, 3 | 14 | 1, 2, 3, 5, 6 |
| 6 | 1, 2, 3 | 15 | 1, 2, 4, 5, 6 |
| 7 | 1, 2, 4 | 16 | 1, 3, 4, 5, 6 |
| 8 | 1, 3, 4 | 17 | 1, 2, 3, 4, 5, 6 |
| 9 | 1, 2, 3, 4 | | |

## DRY RUN

1. With engine dead (or idling with engine control switch in IDLE) and FPC contactor and MG breaker closed to energize 50A wire, apply jumper between GS1 shunt and 19J on P2 interlock.

2. Block CR1 relay, in control stand, closed.

3. Apply second jumper between 19J on P2 and 19H on S21 interlock.

4. CSU should close and shunter should operate upward point by point.

5. Remove second jumper and release CR1.

6. Shunter should return downward, point by point.

7. Block CR1 closed again.

8. Reapply second jumper and fully advance shunter.

9. Remove both jumpers.

10. Release CR1, shunter should return downward rapidly.

## CONTROL PANEL ADJUSTMENTS

Correct operation of the shunter depends on sensitive current relays SCU and SCD picking up and dropping out at definite values. These values are set by adjustment of resistors RH1, RH2, RH3; RH 4 and R1 in the saturable core reactor circuits.

For proper adjustment proceed as follows:

1. Start diesel engine in normal manner.

2. Leave engine control switch in IDLE.

3. Close control switch on control stand.

Before proceeding, wait 10 to 15 minutes until battery voltage is established.

4. Set 400 cycle voltage at voltage maintained by railroad under operating conditions. Check frequently during adjustments to be sure it remains at the proper value. One volt variation in voltage will have a decided effect on sensitive relay operation. With MG set running, AC voltage should be 115 volts ±5 volts. Adjust voltage within these limits, if possible, with resistor 122A in 17FM64 excitation panel. Voltage may be checked by connecting voltmeter leads to wire 57 on EF relay and wire 56 on T1 transformer.

NOTE: Shut down MG set before making any adjustment on resistor 122A.

5. Block in EF relay (to load 17FM64 panel on MG set).

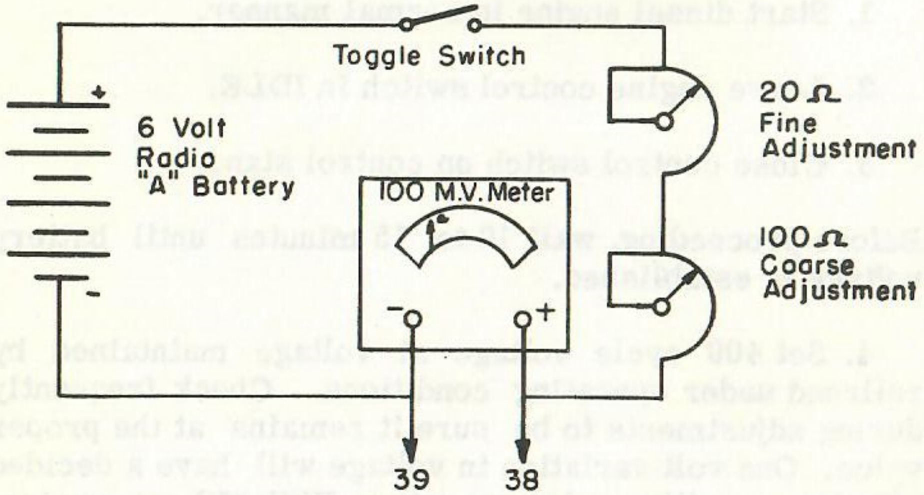
6. Block in CR1 relay (to open CR1's 13-69B contact).

7. Block in TR relay (to short circuit the series set resistor by closing TR contact 78-78A).

8. Block open normally closed 13-19V contact of AR relay with a piece of paper. This will keep IP1 coil circuit open and prevent shunter operation while making adjustments.

9. Install temporary jumper between the braided shunt of GS1 contactor and 19J interlock on P2 contactor in order to operate CSU under control of SCU.

10. Wire 38 which runs from 3000 ampere shunt to 17FM86 panel should be removed from panel stud.



Test Set Schematic

11. Connect positive lead of 100 MV meter to stud 38 and negative lead to stud 39.

12. Connect positive lead of test set (see test set schematic) to stud 38 and negative lead to stud 39.

13. Extremely fine control may be obtained if test set rheostats are of the 2 to 4 watt radio type.

14. Adjust rheostats to give a 100 MV reading on the meter.

15. Measure voltage across the sensitive current relay coils with a DC voltmeter. Voltage should be approximately 45 to 55 volts. Adjust, if necessary, with resistor R1 in series with primary winding of transformer T1. Connect voltmeter to wire 84 on T1 and wire 77 on SCU to check this voltage.

16. Decrease millivolt indication by manipulating test set rheostats until CSD drops out. Pick up CSD by a slight increase of MV indication. Drop out and pick up CSD until accurate readings of pick-up and drop-out values are obtained. CSD should pick up and drop out between 73 and 75. Usually a differential of about 1/2 MV is observed. Since this differential is inherent in each sensitive current relay, it may vary slightly in different relays. Replace any sensitive current relay having a differential greater than 2 MV.

See "RHEOSTAT ADJUSTMENT" for proper adjustment of CSD. Rheostat adjustment affects the operation of sensitive current relays which in turn affects the action of CSD and CSU.

17. Decrease MV indication until CSU picks up, then increase indication until CSU drops out. Repeat pick up and drop out several times until accurate readings have been obtained. CSU should pick up and drop out between 69 and 71 MV. The same differential of 2 MV for CSD will apply to CSU.

18. After completing parallel set adjustments, make the series set adjustments as follows:

a. Remove block from TR relay.
b. Everything else remains the same as for parallel set adjustments.

19. Decrease MV indication until CSD picks up. Obtain accurate readings of CSD pick up and drop out as outlined in paragraph 16.

20. Increase and decrease MV indication until accurate readings of CSU pick up and drop out are obtained. There should be a difference of 4 MV between drop out of CSU and pick up of CSD.

CSD should pick up and drop out between 67 and 69 MV.

CSU should pick up and drop out between 63 and 65 MV.

21. The series set rheostat should be adjusted to obtain these values. Adjustment of this rheostat will not affect the spread. It will either raise or lower both values together, depending on which way it is turned, but it will not move them any closer together or further apart.

22. Make a check on the parallel setting by replacing the block in TR relay and moving jumps from S21-19H interlock to P2-19J interlock and proceeding as in paragraphs 16 and 17.

23. In shunter operation, we have considered the settings in terms of generator amperes, which, when divided by 30, would give MV values for panel adjustments, except for corrections given below.

There is a 2 MV drop in leads from shunt to panel, and a change in setting of 3 MV due to voltage change of MG set from IDLE - no load, to 8th notch - full load.

As the 2 MV lead drop and the 3 MV change in setting are subtractive, there remains a 1 MV correction, which has been added to the settings based exactly on generator current in terms millivolts at the shunt.

When making road checks, with readings taken at 17FM86 panel, if 2 MV are added to the meter reading and the result multiplied by 30, the actual generator current flowing can be found.

24. After adjustments have been completed, operation may be checked as follows:

a. With TR blocked in and jumper between GS1 and P2-19J adjust test set with rheostats until both CSU and CSD are de-energized. Meter indication at this point should be about 71 or 72 MV.

b. Remove paper from AR13-19V contact.

c. Decrease MV indication until CSU picks up. Shunter should up-shunt with time delay between each step of shunting. After several steps of up-shunting have occurred, increase MV indication to 71 MV. CSU should drop out and shunter operation should cease. Increase MV indication to 75 MV, CSD should pick up and shunter should down-shunt with time delay between each step. Decrease MV indication until CSD drops out. Down-shunting should cease.

25. To check rapid run down of shunter without time delay, proceed as follows:

a. Decrease MV indication until CSU picks up. Allow shunter to completely up-shunt.

b. Remove GS1 to 19J jumper.

c. Pull block from CR1. 13-69B contact will close to energize CSD and shunter should run down without time delay.

26. If shunter operation is satisfactory, remove all blocks from relays, remove all test leads, reconnect wire 38 to panel stud and replace all covers.

27. To check mechanical action of shunter when test equipment is not available:

a. To check up-shunting, MG set should be running:
   1. Open CSD manually and hold it open.
   2. Close CSU manually. Shunter should up-shunt without time delay.

b. To check down-shunting, release both relays. Shunter should down-shunt without time delay.

c. If time delay is desired, connect a jumper between GS1 shunt and P2-19J interlock and repeat "a" and "b" of paragraph 24.

## RHEOSTAT ADJUSTMENT

These rheostats may be adjusted to set the pick-up and drop-out values of the sensitive current relays SCU and SCD as follows:

1. RH3 may be adjusted to set the pick-up value of SCD (pick up of CSD).

2. RH4 may be adjusted to set the pick-up value of SCU (drop out of CSU).

Adjustment of RH1 will affect both SCU and SCD values, but it will always affect both relays equally. In other words, it will never raise or lower SCD without also raising or lowering SCU.

Proper procedure in adjusting the relays for parallel operation is to first adjust RH3 and RH4 to obtain a 4 MV spread between the drop out of SCU and the pick up of SCD. When looking up at the bottom of the 17FM86 panel, turn RH3 counter clockwise to raise the pick-up value of SCD (pick up of CSD) or clockwise to lower the value. Turn RH4 clockwise to raise the pick-up value of SCU (drop out of CSU) or counter clockwise to lower the value. A very slight movement of these rheostats will have considerable affect on the relay values as the relays are very sensitive.

After obtaining the 4 MV spread between CSU drop out and CSD pick up, set both relays to their proper values by adjusting the "parallel set" rheostat RH1.

It may be found that RH1 will not have sufficient range to allow adjustment to the proper values. When this condition exists, it can be corrected by further adjustment of both RH3 and RH4. If both the latter rheostats are equally adjusted, they will compensate for a lack of range in RH1.

Assume that the proper 4 MV spread has been obtained and the actual values are:

CSD picks up at 76 MV.
CSU drops out at 72 MV.

Also assume that the values cannot be lowered with RH1 because the latter has already been turned against its stop. The values must be reduced in value to 75 MV and 71 MV respectively.

Since RH1 cannot lower the values any further, adjust RH4 to lower the CSU drop out to 70 MV and adjust RH3 to lower the CSD pick up to 74 MV. The proper values can now be obtained by turning RH1 away from its stop to raise the values to 71 MV for CSU drop out and to 75 MV for CSD pick up.

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